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DIRECTIONS

FOR

LAYING OFF SHIPS

ON

THE MOULD-LOFT FLOOR.

WITH SOME INSTRUCTIONS FOR

DRAWING SHIPS IN PERSPECTIVE,

ETC. ETC. ETC.

ORIGINALLY DESIGNED FOR THE USE OF THE LATE SCHOOL OF NAVAL ARCHITECTURE, AND THE SHIPWRIGHTS IN THE MOULD-LOFT.

BY JOHN FINCHAM,
MASTER SHIPWRIGHT OF CHATHAM DOCKYARD, AND LATE SUPERINTENDENT OF THE SCHOOL OF NAVAL ARCHITECTURE.

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PREFACE.

THE practical part of Naval Architecture comprises the delineation of the lines of a ship on a floor, technically called "Laying Off," and the actual construction or building of the ship. When the constructor has completed a design, and made correct drawings, these are transferred on a full scale to a large floor, for the purpose of having moulds made to the forms of the different timbers that compose the ship; according to which the timber is first sawn, as nearly as this branch of workmanship admits of, to its true dimensions; and by which it is afterwards trimmed correctly by the working shipwright.

Unless due attention be paid to Laying Off, considerable injury may be done to a good design, by deviating from the drawings. Accuracy in making the moulds is also necessary, in order to insure the economical appropriation of timber; and it also facilitates the execution of the workmanship.

The following directions on this subject were originally intended for the sole use of the Students at the School of Naval Architecture in Portsmouth Dock-yard, and the Shipwrights employed in laying off on the mould-loft floor. The Author has not attempted to substitute for the ordinary technical terms, expressions which might be more generally conformable to geometrical science, as the latter would not have been so fully understood by the workmen; and by the students, in their subsequent official situations, the common technical terms would be preferred, as more convenient in carrying on their duty.

Even if the Treatises on Laying Off, by Stalkartt, and Steel, had no disadvantages besides those incident to "great books," a smaller work on the subject would be useful. And the present work claims no farther merit than that of usefulness. A few new methods, more correct than the Author has before seen, he hopes will be found serviceable in the practice of this part of the science. Methods are in several cases given, differing in the length of the operation, which may be used according to the judgment of the shipwright, as a greater or less degree of accuracy may be required. Less time, however, is saved by inaccurate methods than is often expected; and disadvantages frequently arise from them, which more than counterbalance what is thus gained in time.

A few examples are given in this work, of greater difficulty than may be supposed ever to occur in the practice of Laying Off, as illustrations of the means by which any section of a ship may be delineated.

The Author has also given, in an Appendix, an example of Taking Off, and of expanding the body of a ship; and at the end, a few Notes, containing the methods of applying the moulds, and trimming some of the more difficult timbers.

ADVERTISEMENT

TO THE SECOND EDITION.

THE Author, in publishing his "DIRECTIONS FOR LAYING OFF SHIPS ON THE MOULD-LOFT FLOOR," had considered its utility as more particularly adapted for the Students of the School of Naval Architecture, and for those employed in the Mould-loft in the Royal Dockyards; but the numerous applications that have been made for copies since the First Edition has been out of print, have induced him to print a Second.

In the former Edition, small lithographic Diagrams were given as illustrations; but with a view to increase the utility of the Work, a series of copper-plate Engravings, of a large size, explanatory of the manner of laying off the body of a ship, and as examples for laying off the different timbers and the several parts of the ship, are now added in a separate form.

The Author has, likewise, in an Appendix, added some Directions for Drawing Ships in Perspective, in different positions, which he hopes may be useful, as he is not aware of the existence of any other Work on this subject.

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ON
LAYING OFF SHIPS.

Introductory Observations.

THE building of a ship, like that of every other structure in which the mechanical arts are employed, may be described under two general heads: the one comprising the construction or design, and the other, the practical operations connected with the erection. The principles involved in the construction of a ship require accurate investigation, as they include much more than the preparation for the proper degree of strength, or for the suitable and firm union of the parts: because a ship is a body not designed to rest on a permanent basis, but adapted for motion, and to pass through a resisting medium; and thus, while its strength and the combination of its parts must be such as to resist continuous and varied impulses, it must present a form that will meet with the least possible resistance in its passage through the water; while the whole adjustment of its body must be such, that, during its oscillations, the motion may not be uneasy and irregular. The principles on which the form of the body of a ship depends, are to be especially attended to; for, when opinions relative to the best form are acted on, without the investigation of the principles on which that form depends, we can never trust with any degree of certainty to the grounds on which they may have been founded, and we shall only acquire imperfect views of the real nature of the subject. Nor is the adoption of principles, rather than of opinions, less desirable, in giving the proper degree of strength together with the proper combination of the parts; since, by attending to those points that are established in mechanical science, respecting the strength and stress of materials, we obtain certainty in the place of uncertainty. We thereby know how to produce stability and the suitable degree of strength, with proper economy in the application of the materials; and thus we secure simplicity of design, with ease in execution, and produce an economical and durable structure.

To give, therefore, a proper form, with a just economy of materials, should be the great object in the construction of ships; and, to accomplish this end, a knowledge of the practical operations necessary to execute the design must necessarily be joined with the study of the construction. How often a skilful design has been perverted and ruined by those who have executed with unskilful hands, we cannot determine; but if we may judge by the varied performance of ships said to be built from the same design, the instances must be very numerous.

To understand construction, or to possess a knowledge of the principles on which it depends, is as necessary to the ship-builder as a knowledge of perspective is to the painter. It is only by a clear perception of the object to be attained, that we can with certainty and ease form a good design; and it is only when science lights the way, and enables us to take a survey of the whole at once, that we can execute with confidence, and carry on the whole operation as an ordinary matter of business.

It is nothing but profound ignorance of the nature of ship-building, that can lead the student to imagine, when he has made a draught,—even if it should be formed on something like established principles,—that he is competent to build a ship; for to give a draught, or the lines, as it is commonly termed, is to perform but a small part of the operation; with this knowledge alone he can have very slender pretensions as a ship-builder; and, if left to himself, the chances are, that the ship he builds will not be much in accordance with the design he has proposed.

With a design properly made to scale, on paper, the shipwright has next to take care that his lines are correctly formed at their full size; that he may be able to give the correct shape of the timbers, in whatever direction it may be necessary for the planes of their sides to stand in relation to the body, to give the proper support.

Laying-off is the process of transferring the lines, that give the form of the body, to their true size, on an extensive floor prepared for the purpose, so as to obtain the correct form of all the timbers that compose the frame of a ship, and of the other principal timbers. In this process the greatest precision is required, to avoid producing a distorted design, and risking a wasteful consumption of timber.

The Process of Laying off upon the Mould-loft Floor, so as to forward the Conversion of the different Timbers.

1. In proceeding with the explanations required for laying off the body of a ship, it is taken for granted that the student is conversant with the names of the various timbers of the frame, and the manner in which they are combined; if not, it is necessary for him to study these points first, which may be done by consulting the author's "Outline of the Actual Building of a Ship."

2. When the draught is designed from which the ship is to be built, the laying off upon the mould-loft floor is next to be attended to; which should be proceeded with in such a manner as to be least subject to error, and, as far as practicable, that the conversion of the timbers may go on at the same time, to prevent any delay in proceeding with the structure. The moulds, therefore, should be made for the different timbers as they are laid off, beginning with the stem, stern-post, foremost and aftermost deadwoods, and fore-foot; which, with the shift of deadwood upon paper, should be sent out immediately for providing the pieces.

Definitions of the different Plans as distinguished upon the Floor, and how they are mutually transferable.

3. In laying off, there are three principal plans, which are distinguished by the names of sheer, body, and half-breadth plans. The sheer plan is that upon which all lines are projected as to height and length; it gives the vertical longitudinal form, and from it lines are transferred to the half-breadth as to length, and to the body as to height.

4. The body plan is that on which the form of the ship is shown by transverse sections perpendicular to the keel, which are transferable to the half-breadth plan as to breadth, and to the sheer plan as to height.

5. The half-breadth plan is that on which is shown the form of the body by horizontal and diagonal longitudinal sections, from which are obtained other sections in the body plan,—such as the intermediate transverse sections, and the oblique sections, as the cant timbers.

6. The disposition of the several plans on the mould-loft floor, and the number of lengths in which the ship is laid off, depend upon the length of the floor; also how the stem and stern-post, heights of breadths and body, are disposed, on its breadth. When of length sufficient to lay off in two parts, and of breadth sufficient to admit the stem and heights of breadths to be placed at their full heights, it is necessary then only to transfer the different lines from the draught to the floor, from the scale to the common foot; making the stations of the timbers in the fore body answer for those of the after body, which they will do, being at the same distance apart in both bodies, except the $\frac{X}{4}$ distance, which is greater, in consequence of the single timber:

the lines for each body must always overrun at least two stations of the other body.*

7. When the floor is not sufficiently long to take the ship in two lengths, the laying off in that case must be in as few lengths as possible, allowing the lines in one length to overrun at least two stations in the other, so that there may be a certainty of the body corresponding and being fair longitudinally; and when the floor is not sufficiently wide to take the whole height of the stem and heights of breadths, the stem and body must then be laid off with their vertical position the lengthways of the floor, and the heights and distances be transferred from one plan to the other by means of lines got into corresponding distances above the upper edge of the keel in each plan. As the endings of the horizontal and diagonal sections may be taken from the stem and stern-post, and transferred to the half-breadth plan by means of the foremost and aftermost perpendiculars, *they* should in consequence be drawn in each plan according to their relative situations, and in order to obtain the heights of breadths, port-sills, top-side, &c. In the sheer and body plans, a level line should be drawn on the *draught*, at such a height above the upper edge of the keel as will take off from the extreme height as much as the floor is too narrow; then, in the sheer plan on the floor, from this corresponding level line, set up the heights of the port-sills, top-breadth, top-side &c., at the different stations, and run the curves off on the floor; when fair, transfer them to the body plan, by setting the height above the same line in this plan at each station, and draw in curves, so that the correct heights of the port-sills, top-breadth, top-side, &c., may be in the body plan.

The middle Line of Half-breadth Plan and upper Edge of Keel in Sheer Plan.

8. On one side of the floor, extending the whole length, is drawn a straight line, which is made to answer for the middle line of the half-breadth plan, and for the upper edge of the keel in the sheer plan. This line will likewise answer for the middle line of the body plan, supposing the vertical position of the body to be laid lengthways the floor, by the floor being too narrow to allow of the body being laid

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* The lines in the half-breadth plan are made to overrun, that there may be a certainty of the fore and after bodies being in a fair surface longitudinally. The five-fourth distance is set off, that a single timber may be introduced, to prevent, where the bodies unite, the butts, or heads and heels, coming together, through their being on the opposite side of the frame in the two bodies.

athwart. This line is also made to answer for the middle line of one body and for the boundary line of the other; and is in general placed a little more than the depth of the keel and false keel from the side of the floor. To this line, a thin batten with a straight edge is fixed, for the convenience of butting the measuring batten when setting off the distances.

To place the Foremost and Aftermost Perpendiculars and Stations of the Timbers.

9. Perpendicular to the line representing the upper edge of the keel, draw in the foremost and aftermost perpendiculars, also the stations of the timbers; these stations are made to answer both for the sheer and half-breadth plans.—The foremost perpendicular must be drawn in at such a distance from one end of the floor as to allow room for the head to be laid off, provided the length of the floor will admit, if not, leave room for the stem only. From this perpendicular set off the station both of the foremost timber and dead-flat, and divide the intermediate distance according to the room and space; placing three stations abaft dead-flat, in order to regulate the bodies regarding the $\frac{5}{4}$ opening. With respect to the after body, the aftermost perpendicular should be so placed as to bring in for this body as many of the foremost stations as possible, which will save trouble and prevent a confusion of lines. From the aftermost perpendicular, set forward the distance of dead-flat, and, as a proof of its correctness, try how the distance to some station abaft it corresponds; and if the whole together,—that is, if from the foremost perpendicular to dead-flat, added to the distance of the aftermost perpendicular from some station, together with the distance from this station to dead-flat,—make the whole space between the perpendiculars as given in the dimensions, these stations are correct.

To get the Stem, Stern-post, and Counter Timbers, in the Sheer Plan.

(E P; Fig. 1, Plate I.)

10. Draw in the sheer draught a line parallel to the upper edge of the keel to the height of the wing transom at the middle line, and one upon the floor to correspond to its height, for the convenience of taking off from the draught, and for transferring heights above it, which will be more convenient than transferring them from the upper edge of the keel. Upon this line take the distance from the after perpendicular to the after edge of the rabbet of the stern-post, also on the upper edge of the rabbet of the keel, and set them off on their respective lines on the floor; draw a line for the after edge of the rabbet, and another line before this to the breadth of the rabbet for the fore edge, which will give likewise the after part of the wing transom at

the middle line; next draw in the after and fore edges of the stern-post, by taking what it is abaft, and before the after edge of the rabbet at the height of the wing transom and upper edge of the keel. On the sheer draught, draw a level line at the height of the lower knuckle of the midship counter-timber, and one upon the floor to correspond to it, as A B; then, upon this level line take the distance aft of the knuckle from the after perpendicular C D, and set it off upon the floor; from this spot and to where the fore edge of the rabbet cuts the level line, E F, at the height of the wing transom, draw in the lower counter at the middle, to the curve as upon the draught, as E G A, which curve may be obtained by drawing any number of intermediate level lines, and taking the distance aft upon them from the after perpendicular. To get the lower counter at the side, set below the level line, A B, drawn for the lower knuckle of the midship counter-timber, what the lower knuckle is to round down, and draw the line *a b;* and from where the level line at the height of the wing transom cuts the fore edge of the rabbet, draw a line, E *e*, to the sheer of the wing transom, and below and parallel to it another, *mn*, to what the transom is to round down; and upon this line set off the round forward, *i*, of the wing transom, which will be the place for ending the lower counter at the side. From this ending, to where the round down of the lower knuckle, *a*, cuts the midship timber, draw in the curve of the lower counter, *a d i*, at the side similar to the midship one: this will be sufficient to be done to these timbers at present, as the whole projection of the counter timbers cannot be obtained correctly until the top-side is run off; yet it is necessary to have the lower counter, as the main breadth line aft generally ends on it.

(B C X; Plate II., Fig. 2.)

11. In laying off the stem, the fore edge of the rabbet is first got in by drawing any number of lines upon the draught, and others to correspond to them on the floor; and drawing a curve, *d e*, through the spots, making the lower part come in fair with the lower edge of the rabbet of the keel. If the rabbet is on the after edge, the fore edge of the stem is set off parallel to it, if not, the distance may be taken and set off upon the level lines, and the curve, *a b c*, got in; then the after edge is set off parallel to the fore edge, making fair with the upper edge of the keel.

To place the Body Plan upon the Floor. (Plates I and II., Figs. 1 and 3.)

12. The position of the body, as before described (8), depends on the size of the floor. When the vertical position is placed athwart the floor, one of the stations of the timber is made to answer for the mid-

dle line, and lines, *xy*, are drawn on each side, and parallel to it, at half the moulded breadth, for the boundary lines of the two bodies: in this case the middle line of the half-breadth answers to the upper edge of the keel. But if it is necessary to place the vertical position of the body lengthways on the floor, then the middle line of the half-breadth plan answers to the middle line of one body, and for the boundary line of the other, and a line is drawn parallel to it, at the distance of half the moulded breadth, to answer for the other boundary and middle lines; taking, in this case, one of the stations for the upper edge of the keel.

To get in the Half-Siding of the Stem and Stern-post.

13. On the line intended for the middle line of the fore-body, set off the heights of the head of the stem and the lower side of the lower cheek; at those places, and on the upper edge of the keel, set off half the given dimensions of the stem, and draw a line in for the half-siding, as given in the table of dimensions; within it draw another, to the depth of the rabbet; then, upon the middle, in the after body, set up the heights of the post and deck: at these places, and at the upper edge of the keel, set off the half given dimensions of the stern-post; draw a line in for its half-siding, and within it another for the depth of the rabbet.

To get in the Height and Breadth of the Main Breadth Line.

14. In proceeding with the laying off, the height and half-breadth of the main breadth line must next be run off, so as to obtain in the body plan a fixed spot for every transverse section or timber; these heights and breadths are taken from the draught, for convenience of setting off, in the following order:—

MAIN BREADTH AFTER BODY.

FRAMES.	Height.		Half-Breadth.	
	Feet.	Inches.	Feet.	Inches.
⊕				
3				
5				
7				
9				
1				

From this table form they are set off on the floor to the common feet: the heights and breadths may be set off at the same time by having a measuring batten sufficiently long, and by making distinguishing marks round the spots as they are set off; by so doing considerable time is gained. The spots being obtained on the floor, a batten is penned through them, and in making it fair, great care must be taken to deviate as little as possible from the spots; if an alteration should be necessary to get a fair curve, it must be made by passing without one spot and within another, if practicable; for by constantly going without or keeping within, the breadth is affected, which may considerably alter the displacement; observing always to keep the batten fixed, at dead flat, to a spot for the moulded half-breadth.

To obtain the Endings of the Main Half-breadth Line.

15. To end the main half-breadth line forward, draw parallel to the middle line in the half-breadth plan, the half-siding of the stem, taken from the body plan at the height of the main-breadth, and square down to this half-siding where the main breadth cuts the fore and after edges of the rabbet. Then, make the point where the fore edge of the rabbet cuts the half-siding, the centre; taking the breadth of the rabbet, as squared down, as the radius; describe an arc towards the middle line, and let the main breadth line run in fair with the back of this arc. To end the main breadth line, aft, square down where it cuts the lower counter at the side, and upon this squaring down set off the breadth, as given in the draught.

To transfer the Main Breadth from the Sheer and Half-Breadth Plans to the Body Plan.

16. The height and breadth of the main breadth line are transferred to the body plan, by taking the heights in the sheer at every station, and drawing level lines at those heights in the body plan: then, upon these lines set off the different breadths of the corresponding stations, taken from the half-breadth plan; by which means a spot is obtained in the body plan, at the height of the breadth for every timber.

Radius of Main Breadth Sweeps.

17. When the body sweeps at the main breadth, take from the body at the draught the radii of all the timbers, and set them off on the floor in the half-breadth plan. Through the spots draw a curve, from which may be obtained, when wanted, the radii of all the intermediate sections; from this curve take the radius of every section and set it off on its corresponding height in the body plan, from the half-breadth spot previously obtained, and from these spots as centres, sweep down, from the

main breadths, arcs of circles, as far as the curve of the body will allow: then draw a curve through the centres of breadth, and rase in the level lines between them for the heights of breadths. But should the body have no main breadth sweeps, the level lines for the heights may be rubbed out, as they are only struck in with chalk, for the purpose of getting in spots for the breadth at every station, at the height of the main breadth.

To complete the Body below the Main Breadth.

18. Draw in the body plan upon the draught the diagonals for the heads and heels of the timbers, which are determined, according to the new mode of building; by the form of the body, so that the timbers may be as straight as possible, and of such lengths as can be procured. In the middle, between the heads and heels, and from about fourteen to eighteen inches below the floor head, draw other diagonals for the sirmarks, also one between the floor sirmark and keel, for the floor guide. Now, to transfer these diagonals from the draught to the floor, produce them to the line for the upper edge of the keel, and to the boundary line of the body, and take their distances up the middle line and out, and up the boundary line, setting them off on the corresponding lines of the body plan upon the floor, from which draw in the diagonals. Take off from the body on the draught, by means of a scale, the distance that every timber is from the middle line on each, in the direction of these diagonal lines, as in the form which follows, and set them off on the floor.

DIAGONALS.

FRAMES.	Floor Sirmark.		Floor Head.	
	Feet.	Inches.	Feet.	Inches.
⊕				
B				
D				
F				
H				
K				

Pin a thin batten through the distance thus obtained, and for the present chalk in the curves for the timber, bringing the batten in fair with the back of the arc of the main breadth sweeps.

19. To end the timbers at the lower part, where they come upon the straight and parallel part of the keel, draw below the upper edge of the keel a line parallel to it, to the depth of the rabbet; upon this line, and upon the upper edge, set off a spot from the middle line, equal to the half-siding of the keel; and from these two spots describe towards the middle line an equilateral triangle, its sides being equal to the depth of the rabbet; and it is to the back of the upper arc for forming this triangle that the timbers must be brought in fair. To end the timbers aft, where the keel tapers, strike in below the middle line in the half-breadth plan, the half tapering of the keel, and within it the depth of the rabbet; then, at the station of every timber in the half-breadth plan, where the keel tapers, take the distance from the middle line to the line for the inside of the rabbet, and set it off, on its *proper height*, from the middle line in the body plan, which gives the ending. To end these timbers forward, which come upon the tapering of the keel, the same must be done as for the after timbers; but where the keel curves upwards, the line for the inside of the rabbet must be drawn in the sheer plan. To obtain the place of the inside of the rabbet on this plan, it will be sufficiently correct to take the middle at the upper part of the stem, and one-third from the fore edge at the lower part; then, where the stations cut this line, to take their heights from the upper edge of the keel, and transfer them to the body plan; setting them off on the line for the inside of the rabbet in this plan: the same is done for those timbers which end upon the rabbet of the stern-post.

To fair the Body longitudinally.

20. Having thus got in the body below the main breadth, it becomes necessary to try its fairness longitudinally, by running off different longitudinal sections; and though it may not be desirable to run off on the floor no more lines than necessary, both on account of dispatch and to prevent confusion, yet as a fair body is the main object, we must spare no pains nor number of lines to effect it. The diagonal lines, as already got in upon the body, may be run off first, which will prove the body in the directions in which they cut it. Take upon a thin-edged batten in the diagonal direction the distances of every timber from the middle line, and set them off from the middle line in the half-breadth plan on the corresponding stations, and pin a thin batten to the spots.

To end the Diagonal Lines.

21. To end these curves forward, take from the body plan the height

from the upper edge of the keel, to where the diagonal cuts the outside of the stem; take also the height to where it cuts the inside of the rabbet; and transfer these heights to the sheer plan, the former so as to cut the aft side of the rabbet of the stem, and the latter so as to cut the inside of the rabbet; squaring down these two spots to the middle line of the half-breadth plan: then, take from the body, in the diagonal direction, the distance from the middle line to where the diagonal cuts the outside of the stem, and set it off in the half-breadth plan, on the line squared down from the after edge of the rabbet, which will be a spot for the ending of the diagonal, if the form of the body be such as to require the curve to end at the after edge. Next take the distance on the diagonal in the body plan, from the middle line to where the diagonal cuts the inside of the rabbet, and set it off in the half-breadth from the middle line, on the line squared down from the sheer plan for the inside of the rabbet, which will be a spot for the ending of the diagonal, in case the curve ends at the middle of the rabbet; this will be easily seen, for in bringing the curve down to this last spot, if it should fall within the former one, it is properly ended; should it fall without the former one, it must be brought to it, which will be the proper ending of the curve. The diagonal lines aft, which cut the body below the wing transom, are ended in the same manner as those forward; and when they cut the wing transom, it will be necessary, before they are ended, to get in the margin.

To draw the Margin of the Wing Transom in the Body, Half-Breadth and Sheer Plans. (Plate I., Fig. 1.)

22. A level line, EF, must be drawn in the sheer and body plans, at the height of the wing transom, at the middle line; and in the sheer plan, where it cuts the fore edge of the rabbet of the stern-post, draw a line, E *e*, to the sheer that is intended to be given to the transom, and below it, a line parallel, as *m n*, to the round-down that is as intended to be given to it; upon this last line set off a spot, *i*, for the round-forward, and this spot will give the round-down below the sheer, in the sheer plan, which must now be transferred to the body and half-breadth plans. Project its height into the body plan, and there draw a level line, *i k*; also, project down its distance forward into the half-breadth plan, and draw a line there, *s i*, perpendicular to the middle line; upon this line, and upon the level line just drawn in the body plan, set off the given half-breadth of the wing transom, which gives a spot in the body plan for the round-down below the sheer, and a spot in the half-breadth plan for the round-forward of the wing transom. Then, to get the curve between this spot and the middle line, draw in the half-breadth plan the round-forward, by squaring down from the sheer where the

middle line of the wing transom cuts the fore edge of the rabbet, so as to cut the middle line of the half-breadth plan; from this spot *c*, to the spot *i*, for the half-breadth of the wing transom, describe a curve to an ellipse. To obtain this curve, draw several lines parallel to the middle line, one of which, *op*, must be placed at the half-siding of the deadwood from the middle line, which will answer, when run off in the sheer plan, for the stepping line; another must be placed, *i c*, at the half-breadth of the wing transom, and others between these, at equal distances of about 16 or 18 inches apart: though, for correctness, when laying off the transoms, other lines may be placed at half the common distance; one, *i g*, next to the one at the extremity of the wing transom, and another, *o g*, next the stepping line. These lines, which are commonly called buttock lines, may next be transferred to the body plan, drawing them parallel to the middle line, and at the same distance from it as in the half-breadth; then, from the point *i*, in the sheer plan, draw a line, *i x*, upwards, parallel to the rabbet of the post, to cut the level line, EF, at the height of the wing transom, and square down the point *x*, to the buttock line, *i c*, at the extremity of the wing transom; then, from this point to the point *c*, at the middle line, describe a portion of a circle, *c p o*, and where each buttock line cuts it, project spots up to the level line, EF, at the height of the wing transom, and from these spots draw lines downwards, parallel to the rabbet of the post. When this is done, draw in the body plan, below the level line, F N, at the height of the middle of the transom, an arc of a circle, N *m o*, to the round-down of the transom, square to the sheer; and where each buttock line cuts it, take its distance below the level line, and set it off on the line E *x*, square to the sheer, below the sheer line at the middle of the transom in the sheer plan, and from these spots draw lines parallel to the sheer. Then, where these lines cut the lines drawn (downwards from the level line EF, at the height of the wing transom) parallel to the rabbet of the post, project spots to the corresponding buttock lines in the body plan, and draw a curve, N *o c*, through them; this will give the round-down of the transom below the sheer, and project them likewise down to the corresponding buttock lines in the half-breadth plan; and draw a curve, C *o i*, through them; this will be the round-forward. Then, by drawing a curve, E *o i*, through the intersection of the lines parallel to the rabbet of the post and sheer of the transom, the curve for the upper side of the wing transom is obtained in the three plans: below the curve for the upper side of the transom, in the body plan, draw another parallel to it, the depth of the margin, which is called the margin line; and where this lower curve cuts the half-siding of the stern-post, project it to the fore edge of the rabbet in the sheer plan; and square it down to the half-siding of the post in the half-breadth plan. When this is done, draw a curve parallel to the round-forward of the transom, which will give the margin line in the half-breadth plan; from this the margin must now be obtained on the sheer plan; to do which, square up from the half-breadth plan, where the buttock lines cut the margin in this plan, and on these lines project from the body plan where it is cut by the corresponding buttock lines. A curve passing through these spots gives the margin in the sheer plan, and likewise the ending of the buttock lines in this plan.

To end the Diagonal Lines which cross the Margin.

23. In the body plan, take the distance square to the middle line from where the diagonal cuts the margin, and set it off in the half-breadth plan, perpendicular to the middle line, so as to cut the margin; at this intersection, *n*, draw a line, *n x*, square to the middle line; then, in the body plan, take the distance from the middle line, in the direction of the diagonal, to where it cuts the margin, and set it off from the middle line in the half-breadth plan on the line, *n x*, just squared out; which spot, *x*, will be the ending of the diagonal.

24. The body being faired by the diagonals, it would be well to prove it in other directions, more oblique to its transverse curvature: this may be done by horizontal and vertical longitudinal sections. The buttock lines, which have already been got in the body and half-breadth plans, will answer for fairing the after body in a vertical longitudinal direction. These lines are run off in the other plan, by taking the height from the body plan where each timber cuts them, and setting off those heights on the corresponding timbers in the sheer plan; a curve passing through the spots will give the vertical section, which will end at the squaring up of the corresponding buttock line already got in for obtaining the margin. To prove the body in a horizontal direction, strike in upon the after body level lines at equal distances from that at the end of the wing transom, K *i*, from about two to three feet apart; strike them also in the fore body, and likewise in the sheer plan, across the stem and stern-post. To run these lines off, from the body plan take the horizontal distance from the middle line to where every timber cuts them, and set them off from the middle line in the half-breadth plan on the corresponding stations of the timbers; and at the after body, where these lines in the sheer plan cut the buttock lines, square them down to the corresponding buttock lines in the half-breadth; and through the whole of these spots pass a curve, ending the one at the height of the wing transom, at the point where the buttock line drawn at the half-breadth of the transom intersects the round-forward at *i*; and ending those below, by squaring down

from the sheer plan to the middle line of the half-breadth plan their intersection with the middle and fore edge of the rabbet of the post; setting off on these squarings down respectively, the half-breadth of the post, and distance from the middle line to the inside of the rabbet, taken from the body on the corresponding level line, observing the same method for determining whether they end at the middle or outer edge of the rabbet, as was explained for ending the diagonals (21). To end the level lines forward, square down where they intersect the middle and after edge of the rabbet in the sheer plan, and set off on these squarings down the half-breadth of the stem and end them as in the after body. Should the timbers taken from the draught not be sufficient to prove the body at the extremities, other timbers, called proof timbers, must be got in forward and aft, nearer to the extremities, and the diagonal, vertical, and horizontal sections corrected by them. The body being thus faired and proved by vertical, horizontal, and diagonal sections, the timbers, and all sections that it is necessary to preserve, are rased in.

To get the Form of the Top-Side on the Floor.

25. The mode of proceeding with that part of the body on the floor which is above the lower height of breadth, must depend on the manner in which the top-side is constructed; if it should be constructed with a straight of breadth and upper breadth sweeps, the first thing will be to run off in the sheer plan on the floor the heights of the upper height of breadth, top-breadth, and top-side, which must be transferred to the body plan at every timber, and level lines stuck in for them; and from where each timber cuts the lower height of breadth, square up to the corresponding upper height, which gives the straight of breadth in the body plan. Then, from where these squarings up cut the different level lines or heights, describe upwards arcs of circles, the radii of which must be taken from the draught. The breadths of top-breadth and top-side must now be got in the half-breadth plan, after which they must be transferred to the body plan, by taking the breadths at every timber and setting them off on the corresponding heights already obtained; from these breadths to the backs of the arcs described upwards, from upper height of breadth, draw curves similar to those in the draught. The whole of the top-side being of the same form (if constructed so), except where the flair of the body forward gives it different. As soon as the midship timber is got in, a mould is made to the form; from the point of contrary flexure upwards, which is called the back hollow; this mould is made to extend higher up and lower down, increasing in curvature downwards, and lessening in curvature upwards; as by it the upper part of all the timbers, except those

forward, are got in, keeping it well to the back of the arcs and to the spots for the top-breadth and top-side: the timbers forward must be got in by the eye, and faired by a number of level lines. Having completed the timbers of the top-side, their fairness must be obtained by running off several level lines between the heights of main and top breadth and port-sill lines. In the after body, these level lines should be so placed, that by means of their ending, the fore and aft view of the side counter timber may be obtained; one must, therefore, be placed at the height of each knuckle, and as many between the lower knuckle and wing transom, and between the upper knuckle and top-breadth as may be thought necessary: the position of the upper counter must now be obtained, in order to get the place of the knuckles.

To get the Counter Timbers.

26. The stern timbers at the middle line and side, as high as the lower knuckle, have already been got in; the height therefore of the lower knuckle is determined. At the place of intersection of the side timber with the midship, draw a line, *a z*, to the rake that is intended to be given to the upper counter; this will be a chord to the curve of the upper counter at the side: upon it set off the depth of the upper counter, which gives the upper knuckle at the side, *z*; at this height, and at the lower knuckle, strike in level lines, *a b* and *z b*, in the body plan, and run them off in the half-breadth plan, producing them beyond the after timber as far as the stern timbers rake beyond it, and keeping their directions between the main and top breadth lines. Upon these lines project down from the sheer plan the upper and lower knuckles at the side; take their breadths at these places from the middle line, and transfer them to the body plan at the corresponding level lines, which gives the fore and aft projection of the side counter timber at the places of the knuckles: proceed in the same manner, by running off level lines, to obtain its projection below the lower knuckle.

27. To determine the place of the upper knuckle at the middle, transfer from the sheer to the middle line of the body plan, the height of the lower knuckle, A, at the middle, and take the depth of the upper counter upon the inclination, *a z*, of the side timber in the body plan, and set it up from this height on the middle line; this gives the height of the upper knuckle, *q*, at the middle, giving an excess of round to the upper counter rail, which should always be the case, as producing a better appearance by increasing in curvature as they proceed upwards. This height must now be transferred to the sheer plan, and a line, A*x*, drawn from the lower knuckle at the middle up to it, parallel to the

line that represents the chord of the arc of the upper counter at the side, which will be the chord of the upper counter at the middle. This method of constructing the upper counter, will much facilitate the setting of the knuckles when actually building, as the two ends of the arc at every timber will be at the same distance from each other in the direction of the timber, and the chords of these different arcs will be out of winding with each other. From the lower knuckle at the middle, and at the distance of the knuckles apart, draw in the curves A $m\,x$ and $a\,n\,x$, of the upper counter; we have then the timbers in the sheer plan as high as the upper knuckle.

To determine the Timbers above the Upper Counter.

28. Draw in the sheer plan, from the upper knuckle at the middle line, the rake, $x\,o$, of the midship timber; and as the round aft of the stern is a portion of a cylinder, the midship timber being parallel to the axis, will be a straight line; but the side timber, not lying parallel to the axis, will have its aft side curved. Strike in upon the sheer and body plans, at the same heights, any number of level lines, and run them off in the half-breadth plan; then, from where the level line, at the height of the upper knuckle, at the side, cuts the rake of the midship timber below the knuckle produced down, project to the middle line of the half-breadth plan; and from this spot to that one already projected down from the knuckle at the side, on the corresponding level line, draw a curve. These curves, which cut the midship timber obliquely, are not circles, because the round of the stern is supposed to be a cylinder, whose axis is parallel to the midship timber; therefore, lines which do not cut the midship timber at right angles are not circles, and must consequently be determined by a particular method; as follows:—Draw perpendicular to the midship timber, a line, S z, passing through the upper knuckle at the side, producing the midship timber to cut it; then, take the distance on this line from the midship to the side timber, and set it off on the middle line in the half-breadth plan, and from this spot to the spot before obtained upon the level line, passing through the upper knuckle at the side, draw an arc of a circle, by the common method, the radius being equal to the semidiameter of the cylinder: this gives a round aft square to the rake, or perpendicular to the axis of the cylinder. Now from this, to obtain the oblique round aft, draw in the half-breadth plan any number of ordinates parallel to the middle line, between it and the spot for ending the level line; where these ordinates intersect the square round aft, take the distances from a line drawn (square to the middle line) through the ending of the level line at the height of the upper knuckle, and set them off in the sheer plan, on the line that was drawn square to

the rake; from the spots so determined draw upwards, lines parallel to the midship timber, and where they cut the level line that passes through the upper knuckle at the side, project down to the corresponding ordinates in the half-breadth plan. A curve through these spots will give the oblique or horizontal round aft of the stern: this is the curve for the whole of the level lines or horizontal sections of the stern; for all sections which are parallel to each other on the surface of the same cylinder, must have the same curvature. The correct right-aft curvature being thus obtained, there now remains to complete, both in the body and sheer plans, the side timber above the upper knuckle; therefore project down from the sheer plan to the middle line of the half-breadth-plan, the intersection with the midship timber of all the level lines which are above the upper knuckle. From these spots draw curves parallel to the oblique round aft; the intersections of which, with their corresponding level lines, must be squared up to the same level lines in the sheer plan; when a curve passing through these spots will give the correct form of the after edge of the side counter timber. But as the level lines in the half-breadth plan were produced without any guide abaft the after timber, and faired only by the eye, it will be necessary to complete the fore and aft projection of the timber in the body plan, before it is finally drawn in the sheer plan; to do which, from the half-breadth plan take the breadths at the endings of the different level lines, and set them on the corresponding level lines in the body plan; through the spots thus obtained pass a curve; if they give a fair curve, the endings of the level lines in the half-breadth plan are correct, if not, these endings must be altered till the curve is fair. The after edge of the side counter timber in the sheer plan must now be altered to conform to these endings, by squaring them up, which will finally give the projection, and may accordingly be rased in. When there are no upper breadth sweeps, nor straight of breadth, the topsides may be got in immediately from the draught; but it is to be recommended in all cases to use a back-hollow, in order to get a fair side, and to give the same curve to the timbers, extending it as far forward as can be applied.

29. The topside being made fair, the timbers which have been drawn in chalk may now be rased in; at the same time rasing in upon them the heights of the top-breadth and top-side, as at those places ribbands will be stationed, and bevelling spots given. As the distance between the main and top breadths will be too great to be without ribbands and bevelling spots, the heights of the port-sills may be got in, as it will be convenient to have them on the moulds; and, from nine to twelve inches below them, lines may be run off in the body and half-breadth

plans for the places of the ribbands and bevelling spots; also one at about sixteen inches above the gun-deck sill for the situation of the cross-spalls; run off, likewise, in the sheer plan, the cutting down and stepping lines. The height of the cutting down is taken from the draught, but it should be proved, by running in the scantlings of several timbers, to see that its height makes a fair curve with the inside of them.

To get the Stepping Line. (Figs. 1 and 3.)

30. The stepping line is obtained by striking, in the body and half-breadth plans, the half-breadth of the deadwood from the middle line, and taking from the body plan the height above the upper edge of the keel to the intersection of this line with every timber, and setting them off in the sheer plan; squaring up also from the half-breadth plan the points where it cuts the different level lines, to their corresponding level lines in the sheer plan: a curve passed through these spots, breaking in fair with the after edge of the rabbet of the stem forward, and fore edge of the rabbet of the post aft, at the place where the half-breadth of the post and stem is equal to the half siding of the deadwood, will give the stepping line in the sheer plan.

To make the Moulds and take the Bevellings of the Square Body.

31. The form of a vertical transverse section in the body plan gives the shape of two assemblages of timbers, and that strength may be given by the connection of the timbers that compose one frame, the heads and heels of those in one assemblage are brought near the middle of those in the other; the moulds, therefore, which are made from the body plan, and which are thin deals formed to the curve of each transverse section, must have one set to overrun the other, agreeable to the shift determined. The floor mould is made equally on each side of the middle line: the first futtock to extend from the deadwood to the distance that it is to overrun the floor head; the second futtock to extend from the floor head to the distance that it is to overrun the first head; the third futtock, from the first to the distance it is to overrun the second, and so on according to the numbers of the timbers. But, in the new system of building, where there are made-floors, the moulds must be formed differently. In this system, the first futtock butts upon a cross timber, which extends equally on each side of the middle line; and instead of the common first futtock, timbers called half floors are used, which abut on the middle line, or overlap each other with a short scarph. (*See Moulds,* Plates I. and II.)

32. In the first case, that is, on the old system, the first, second,

and third futtock moulds are made, so that each may give the form of two timbers and their opposites; therefore, each edge of each mould must have the form of a timber. It is sometimes the case, that one mould is made to give the form of several timbers, by taking spillings; but this is not to be recommended, for to have the true form is of more importance than to save a little board; moreover, the saving would be to a very small extent; for, with care, old moulds may be worked up for several ships, and will be better than when made of new stuff, since being well-seasoned they will not fly. Upon these moulds are marked the diagonals, which are the stations of the ribbands, heads, and heels, and at which places the bevellings of the timbers are given. The heads and heels are distinguished upon the moulds by a single line, in the direction of the diagonals; while the sirmarks or stations of the ribbands are marked by a line crossed thus (✱).

33. Upon the lower end of the first futtock are marked the upper edge of the keel and side of deadwood; the upper edge of the keel being given, in order to apply the cutting down batten when moulding the inside of the timber; as, without attending to this, the timber may be cut so small, that when the ship is dubbed out, it may be found necessary, for want of wood, to carry the cross chock higher up. The side of the deadwood is given for cutting off the heel; it also gives the direction for applying the cutting down batten when moulding the inside. These moulds must be marked on both sides, as the timbers of both sides the ship are moulded by them.

34. In the second case, or new system of building, the moulds are marked as in the first case, with this exception,—that the first futtock moulds butt on the head of the cross timber, and the half-floor moulds have marked on them the side of the deadwood, the upper edge of the keel, and middle line. The floor-mould, in the first case, is made to mould the whole of the floors both in the fore and after bodies; and as in the fore body the floors are on the aft side of the frame, and in the after body they are on the fore side, they will be placed on opposite sides of the mould,—those of the fore body on the after side, and those of the after body on the fore side of it.

35. The floor mould is a batten mould with a joint at the middle line, where it is united by hinges, and is of sufficient depth to take the rising of the most acute floor. The lower batten is made to the form of the midship timber, the outer end batten is fixed to it, and placed in the direction of the diagonal at the floor head; the inner end batten is placed with one edge in the direction of, and at the middle line, and

is equal in breadth to the half-siding of the keel. This batten extends from the upper edge of the keel to such a height as to have marked on it the cutting down of the aftermost floor; the upper batten is straight, and united to the two end ones. Between the second end battens, others are placed as braces in the situation of the diagonals, and in their direction at the floor sirmark, floor guide, and necessary bevelling, and in other places where it may be thought necessary to give bevelling spots. One-half of the mould is made first, from which the other half is formed; the two are then united, as before described, by means of hinges at the middle line. The mould being made, it is laid open in its position upon the floor, and the rising of all the floors squared up on the edge of every batten: to these spots the first futtock moulds of the corresponding timbers are then applied and rased across the battens; the two parts are now folded together, and the rising of the floors upon one half marked upon the other, and rased across the battens again by means of the corresponding first futtock moulds. (*See Floor Mould,* Plate I.)

36. As the battens upon the mould are placed well to the heads and sirmarks of the after body which have in general the most rising, the directions of the heads and sirmarks of the fore body, they must therefore be rased upon these battens, in order to have their true position; the height of the cutting down line for each floor, in order to mould the inside, is now got upon the middle batten, and rased horizontally across.

37. In the second case, or new system, the forms of the cross timbers are given in the same manner as for the floors in the old system, as high as the cross timber head.

38. Where the timbers of the topside are of the same form, one mould for each body is made to the whole of the fourth futtocks and top timbers, by placing the mould at every section and marking on it the alteration of the different timbers at the lower end, by means of the third futtock moulds. In moulding the timbers, these alterations of the form as rased on the mould are bored through with a small gimlet, and the third futtock mould applied to them. When this method is not practised, the moulds are given as for other timbers, marking upon them the height of topside, top breadth, port-sills, and every other place at which bevellings are to be given. (Note 2.)

To take the Bevelling of the Square Body.

39. The square body being a projection of all the timbers or trans-

verse sections upon a vertical plane, it will give the distance that each section is within (or without) the other in the distance they are apart; these distances, therefore, set within or without a square, at the distance the sections are apart, or the room and space, will give the angles formed by the plane of the sides of the timber with the body longitudinally. The manner frequently pursued to obtain these angles or bevellings, is by marking in the half-breadth plan the siding of the timber on each side of the joint, on the different diagonals, level lines, port-sills, main and top breadth lines, taking the distances of these several lines at the spots from the middle line, and setting them off on their corresponding lines in the body plan; with a thin batten or pair of compasses, take the shortest distance of these spots, so obtained, from the joint or timber, and set them off within or without a square at the siding of the timber, which gives the different bevellings. But as this process is tedious, the following is given as sufficiently accurate for practice:—Upon a board whose breadth is equal to the room and space, draw a line square to the edge, and with a thin-edged batten, take from the body plan, at the diagonals and bevelling spots, the shortest distances of the timbers from each other, the standing bevellings being obtained by beginning with the foremost timber in the fore body and the aftermost timber in the after body, taking the graduations of every timber as far as the midship one; the under bevellings are obtained by beginning with the midship one, and proceeding forward and aft to one timber beyond the foremost and aftermost sections, setting off these graduations for the under bevellings below the line squared from the edge of the board, and those for the standing bevellings above it. From these different spots draw lines to where the square line cuts the opposite edge of the board, and the angles formed by these lines with that edge will give the angles made by the planes of the sides of the timber with sections square to the timbers, as they give the bevellings square to the curve. If the body should have a considerable curvature, these lines for obtaining the bevellings must be considered only as chords; in such a case, to obtain the bevelling, a straight-edged batten must be applied to the extremities of the curve between the two joints in the half-breadth, taking the round at the distance of the siding of the timber from the joint; setting it off at the same distance from the edge of the board from the corresponding chord, which will give the bevelling at that place.

40. This method of taking the round is not perfectly correct, because the lines drawn on the board are chords to sections square to the body, whereas the lines in the half-breadth plan seldom are; it is, however, near enough for all practical purposes, as the difference would be in-

considerable. This curvature may be noticed at the extremities; in other parts it is not worthy of attention. The method sometimes pursued to allow for this round is, to take the under bevellings, and reverse them for the standing bevellings; this will certainly leave wood on the obtuse side, but there will be a deficiency of wood on the acute.

Upon the Bevelling Boards. (Plate II.)

41. Bevelling boards are made for each body, to contain the bevellings of the first, third, and all the futtocks that are on one side of the frame; others are made for the floors, second futtocks, and all the timbers contained on the other side of the joint of the frame. The breadth of the boards is, in general, equal to the siding of the lower timbers, and of length sufficient to take the bevellings of all the square timbers in each body that are on the same side of the joint, provided such length be convenient for use. A margin line is drawn from the edge of the board, allowing sufficient room for the distinguishing number or letter of the timber. Upon this line are set off equal distances, about half an inch apart; it is from these divisions that the different bevellings are drawn. All these bevellings, at the same sirmark or head of the different timbers, are placed together, and in the midst of them, at the center of the board, is swept a circle, in which is expressed the name of that sirmark or head. Each bevelling board is headed with the different timbers, the bevellings of which are given on the board.

42. The boards being prepared, the bevellings are transferred to them by means of the board upon which the graduations have been set off. This is done by placing the two edge to edge, and applying a straight batten to the different bevellings on the broad board, bringing the corresponding spots on the unmarked board well to it, and rasing across accordingly. In case any bevelling board should be lost, duplicates are in general kept at the mould loft as a reserve.

The Stem Mould. (Plate II.)

43. The stem mould is a batten mould, having one of the battens fastened to its after edge, and equal in breadth to the rabbet when it is on the after edge; another batten, about two inches and a half wide, is made well to the curve of the fore edge, which two battens are united together by cross battens and give the moulding of the stem. These cross battens may be placed at the height of every sirmark, in order to give the stations of the harpins; they may also be placed at the main breadth, top breadth, and port-sills. A mould is made to each

piece of stem separately, giving the form of each scarph; upon the stem mould is marked the height of the decks, for placing the knighthead bolts, and the height of the cheeks, for the tapering of the siding: a perpendicular line must likewise be got upon it, for setting the stem in its proper position, giving the distance of this perpendicular from some square station. (Note 3.)

The Apron Mould. (Plate II.)

44. The mould for the apron is made to the concave or aft side of the stem mould; its scarphs give shift to those of the stem. The apron mould, if of considerable width, should be a batten mould; otherwise, being heavy, it would be liable to split. The width of the apron is governed by the scantling of the timbers, so that the knighthead may have sufficient seating; to obtain this, the scantling of the timbers at different heights should be run off, and taken in a fore and aft direction and set off accordingly. It is necessary to have one sirmark upon the apron mould, observing to mark the same on the mould of the stem, so that they may be brought into their true position with each other.

Fore-foot Mould. (Plate II.)

45. The mould which is made to the foremost piece of keel or fore-foot is a batten-mould, with the upper batten made to the curvature of the rise of the upper edge of the keel, equal in breadth to the rabbet; the lower batten is straight, coinciding with the lower edge of the keel, about two inches and a half wide, and connected to the former one by battens placed at the stations of the square timbers. The fore end of the fore-foot mould terminates in general at the point where the upper edge of the keel produced cuts the fore edge of the stem; a vertical line drawn from this intersection gives the abutment for the upper part of the gripe, and a line drawn from it upwards, square to the curve of the stem, gives the abutment for the upper part of the boxen scarph, if united by a scarph of this description. Battens should be fixed upon this mould, in order to give the form of this scarph, the lower end of the lower piece of stem mould conforming to it; the fore-foot mould need extend no further aft than the curvature of the foremost piece of keel: it is necessary to mark on this mould the stations of the square timbers and a line for the upper edge of the keel. (Note 4.)

Mould for the Foremost Piece of Deadwood. (Plate II.)

46. The mould for the foremost piece of deadwood is a batten mould, made with its fore end to overrun the apron, conforming to its scarph; it is in general made to extend as far aft as the foremost shift. The

upper part forward of the foremost floor is made to the cutting down line, and abaft the foremost floor it is as high as may be thought necessary for seating the floors; the lower part is made to conform to the fore-foot and stem moulds. The boundary battens are united together by others placed at the stations of the square timbers, which are made also to give the half-siding of the deadwood, their straight edge being well with the stations, and representing the middle line. On these battens set up the height of the stepping, and square out lines from the straight edge; upon these squarings out set off the half-siding of the deadwood; below these heights the battens must have the form of the body, which may be obtained from their corresponding square timbers in the body plan. At the height of the stepping, from the spot denoting the half-breadth of the deadwood out, set in the stepping for the timbers; from this point upwards the battens are made parallel. The position and form of the stepping line are given on the mould by a batten fixed as far as it extends; the disposition of the cant timbers being got in the half-breadth plan, the intersection of the joints with the stepping line is squared up to the stepping on the mould, and battens are placed well to these spots perpendicular to the keel, which give the stations of the cant timbers on the deadwood. (Note 5).

Mould for the After Deadwood. (Plate I.)

47. The after mould is composed of battens, the upper one formed to the cutting down, the lower one coinciding with the upper edge of the keel, and the after one to the after edge of the rabbet of the post; these battens are kept together by others called half-breadth battens, placed at the stations of the square timbers, the forms of which are obtained from the body plan, by which means the half-siding of the deadwood is got at those different places: a batten is placed at the height and to the form of the stepping, and others are placed at the stations of the cant timbers and fashion pieces, as shown in the mould for the foremost piece of deadwood. This after mould is made in general to extend to one square timber beyond the stepping line; the fore part of the inner post must be raised upon it. It is sometimes the case, that the mould for the after deadwood is made no higher than the stepping line, giving distances up to the cutting down at each square timber; it is, however, to be recommended that it extends to the cutting down, as giving it and the stations more accurately. (Note 5.)

Stern-post Mould. (Plate I.)

48. The mould for the stern-post is composed of several battens: one of which is placed well with its after edge, one well with, and equal to the breadth of the rabbet, and another well with the fore side of the

inner post. These battens are connected together by others placed across them, one at the upper edge of the keel, one at the head, and one at the height of the inner post, which butts under the deck transom when there is one, otherwise under the wing transom, and others at the height of each sirmark. It is not always the case that one mould is made both to the stern and inner posts; but it will be found most convenient to do so (as both posts are of the same siding) for giving the bearding line. To obtain the bearding, moulds are made to the half siding of the inner post below the bearding line, which is obtained by squaring down from the sheer plan, where each level line intersects the bearding line, to the corresponding level line in the half-breadth plan; from these spots to the endings of the level lines, moulds may be made, which give the form of the body at those places between the bearding line and the rabbet. To get the bearding of the inner post below where the bearding line cuts the fore side of it, square down the intersection of each level line with its fore side to the corresponding level line in the half-breadth, and make moulds to the form of the body between these spots and the rabbet of the post, as before. Upon the stern-post mould must be marked the bearding line, the joint of the main and inner posts (supposing the moulds for the main and inner posts in one), also the heights of sirmarks, and upper and lower edges of transoms. (Note 6.)

Knighthead and Stem-piece Moulds.

49. These moulds are generally in one breadth, made to project forward at their upper parts to the thickness of the plank for the boxen wood. This boxen must extend downwards, at least as far as two strakes below the head of the stem, so that there may be as few joints as possible in the bed of the bowsprit, and that there may be no short-grained wood just below the bed. The breadth of these moulds is made to the scantling of the timber, leaving the projection for the boxen inside and out; they have marked upon them the sirmarks, also level lines for giving the directions for setting off the bevellings; these bevellings are taken from the half-breadth plan, placing the stock of the bevel parallel to the middle line, and tongue against the level lines: this method of taking the bevellings saves the trouble of laying off the bevelling edge, and for knightheads is equally well applied by the workmen. (Note 7.)

Upon the Cant Timbers.

50. The body of a ship is divided into two parts at the greatest transverse action, the part before it is called the fore body, and that abaft it the after body; and as far as concerns the frame of the ship,

a portion of these bodies, at each extremity, on account of the sides of the timbers not being athwartship, is called the cant body; the one at the foremost extremity the fore cant body, and the one at the aftermost the after cant body. In these bodies, to bring the sides of the timbers as near as possible perpendicular to the figure of the body, and to give the greatest strength by their disposition, the plane of their sides, keeping a vertical position with respect to a horizontal plane, are placed obliquely with respect to the plane of elevation, or a fore and aft line.

To lay off the Cant Timbers.

51. When the sides of the timbers are perpendicular, both vertically and horizontally, to the longitudinal axis, their projection is only required upon a thwartship vertical plane, similarly to the timbers of the square body shown by sections on the body plan; but when the sides of the timbers are oblique to the longitudinal axis, either way, it requires more than a projection, because the forms must be given in the direction of the plane of their sides. To get the proper form, therefore, their inclination to a horizontal plane, or to a longitudinal vertical plane, must be first obtained. Since the plane of the sides of the cant timbers is inclined to the longitudinal axis, this inclination must be got on the horizontal or half-breadth plan.

To get the Inclination of the Plane of the Sides of the Cant Timbers in Half-breadth Plan, forward to the longitudinal Axis. (Fig. 3, Plate II.)

52. The number of cant frames will be governed partly by the rake of the stem and fulness of the bow; if the bow is full and the stem rakes, the cant timbers will require to be carried further aft, or else there will be too much opening at the main breadth (14), or the timbers will be reduced too much at the heel. When the distance they are to be carried aft is determined, run off in the half-breadth plan a horizontal section taken at the height of the hawse-holes, and place the stations of the holes upon it. The foremost hole is now in general placed against the knight-head (49), and the after one so as to allow two timbers to be placed between the two holes. In the middle between the two holes, draw the joint *a′ b′* (Fig. 4), for the foremost cant frame to a suitable cant, or, as near as possible, perpendicular to the curve of the horizontal section; that is, a mean between the fullest and fore-and-aft line; then set off upon the main-breadth line, the station of the next joint, placing it so that the fore edge of the foremost timber in this frame may be cut about from one inch and a half to two and a

half inches by the hawse-hole; and between this station and the joint of the foremost square frame, upon the main-breadth line, space the intermediate joints at equal distances, placing such a number that they may be apart rather more than the room and space; likewise the spaces are upon the middle line; but as the joint of the foremost cant frame only is drawn to cut the middle line, they must be spaced at equal distances from this joint to the joint of the foremost square frame, and to correspond in number with those on the main-breadth line; when their stations are thus obtained upon the main-breadth and middle lines, the joints are then drawn into them. When it requires the joints to be considerably opened to equalize the openings, it will be necessary, in order to be accurate, to draw in two lines, *o p* and *r s* (Fig. 3), for the connecting edges.

To get the Inclination of the Plane of the Sides of the Cant Timbers to the Longitudinal Axis in the Half-breadth Plan aft. (Fig. 1, Plate I.)

53. In the half-breadth plan, upon the level line run off at the height of the wing transom, at the side (22), set off a spot for the aft side of the fashion-piece, which is from 12 to 20 inches from the aft side of the transom, and from this spot draw a line, $x' y'$, for the plane of the aft side of the fashion-piece, drawing it as near as possible perpendicular to the middle water-line; then, between this line and the joint of the after square frame, which is determined according to the form of the body, equally space them upon the middle and main-breadth lines, making their distance apart at the main breadth, rather more than the room and space.

54. If the joints require opening any considerable distance to equalize the openings, there must be two lines got in, as forward, for the connecting edges; they are opened equally from the joint at the main-breadth, and made some times to cross, before they meet the middle line, that the timber may be snaped on the joint side as well as the outside. If one line only is got in for the joints, and the frames are opened considerably, the form will be materially altered.

To lay off the Cant Timbers in the Body Plan.

55. The form of the cant timbers being required, so that the mould may be applied in the direction of their sides, all distances for the correct form must be taken from the half-breadth plan in the direction of the cant, so as to extend the timbers in the body plan, and give a projection upon the plane of their sides. In laying off these timbers, the whole

of the lines before run off in the half-breadth plan for correcting the square body (20), may now be brought into use; but to get their form by the diagonals, a projection of these lines must be first obtained in the half-breadth plan. The lines formed by the projection of the diagonals are called horizontal ribbands; they are laid off by taking the distance perpendicular to the middle line in the body plan, to where each square timber cuts the several diagonals, and setting them off from the middle line, on their corresponding timbers in the half-breadth plan; passing curves through the distance thus obtained, and ending them on the lines squared down for the endings of the diagonals, at a distance from the middle line (according as the corresponding diagonals end at the inside or outside of the rabbet), taken from the body plan square to the middle line, to where the inside or outside cuts the diagonals.

To lay off the Cant Timbers by the Horizontal Ribbands. (Figs. 1 and 3.)

56. Take the distances perpendicular to the middle line, where the cant of the timbers in the half-breadth plan (52 and 53) cut the horizontal ribbands, and set them off perpendicular to the middle line in the body plan, to cut the corresponding diagonals at *l;* this will give spots for the projection of the cant timbers, or places where they would cut the plane of the diagonals. But as they require to be extended, or the form on the plane of the sides to be obtained (55), lines, *l l'*, must be drawn through these spots for the cant distances to be set off on, and as the plane revolves on the middle line, they must be drawn perpendicular to it; take, therefore, from the half-breadth plan in the direction of the cant, the distance from the middle line to each horizontal ribband, and set it off from the middle line of the body plan upon the corresponding squarings out, *l l'*; a curve passed through the distances thus obtained will give the true form of the timbers; but as the diagonal lines do not extend sufficiently high to give the form of the timbers to the topside, spots must be got for them from the top and main-breadth and topside lines; to obtain which, square up from the half-breadth plan where the cant of the timbers cuts these lines to the corresponding lines in the sheer plan, and transfer the heights, where these squarings up cut them, to the body plan, and draw level lines through the spots so determined; then, in the half-breadth plan, take the distances from the middle line to these lines respectively, in the direction of the cant, and set them off from the middle line in the body plan on the heights just obtained, and continue the curves through the spots so found.

To correct the Cant Timbers by the Buttock Lines.

57. Take from the middle line of the half-breadth plan, in the direction of the cant, the distances where the level or water lines cut the cant of the timbers, and set them off from the middle line; on their corresponding level or water lines in the body plan, these distances should come well to the curve of the timbers. If there is not a sufficient number of level lines between the main and top breadth, as run off for fairing the square body (20), or should the distances between the diagonals be too far in any part of the body, other level lines must be run off, till there is a sufficient number to give the form of the cant timbers accurately, and spots are obtained from them the same as before.

To correct the Cant Timbers by the Buttock Lines.

58. To correct the cant timbers by these lines will only be necessary when there is a considerable distance between any of the spots that have been obtained by the level or diagonal lines in the after body, as these vertical sections or buttock lines are seldom run off forward; these corrections are got by squaring up where the cant of the timbers crosses the buttock lines in the half-breadth plan, to the corresponding buttock lines in the sheer plan, which will give the disposition of the timbers, and transfer the heights where the squarings up cut the buttock lines to the body plan, and draw horizontal lines. Then, in the direction of the cant, take the distance from the middle line to where the cant of the timbers crosses the buttock lines in the half-breadth plan, and set them off on the heights before obtained in the body plan; these distances should correspond to the timbers as got in by the level or diagonal lines.

To get the Port-sill Lines upon the Cant Timbers and correct them by the same.

59. The port-sill lines are run off both in the sheer and half-breadth plans to obtain their heights, &c. on the moulds, for the square body; these heights and the heights of the ribbands and harpins below them (29), must likewise be got for the cant timbers, at the same time spots may be got for proving them in the body plan. Square up where the cant of the timbers in the half-breadth plan cuts the port-sill lines, to the corresponding lines in the sheer plan, and transfer the heights to the body plan; then, take from the middle line of the half-breadth plan,

in the direction of the cant, the distances to these lines, and set them off on the heights before obtained in the body plan : this will give spots for the timbers and the height of the port-sills.

To end the Cant Timbers at the Stepping.

60. The stepping line and half-breadth of the deadwood were before got in (30) ; it therefore only remains to obtain the ending. Where the cant of the timbers in the half-breadth plan cuts the half-breadth of the deadwood, square them up to the stepping line in the sheer plan, and transfer their heights to the body plan ; then, in the direction of the cants, take the distance from the middle line in the half-breadth plan, to the half-breadth of the deadwood, and set them off from the middle line on the corresponding heights in the body plan : this will give the proper endings of the lower ends of the timbers.

To lay off the Bevelling Edges of the Cant Timbers. (Fig. 3, Plate II.)

61. In the half-breadth plan, draw lines to represent the bevelling edges of the timbers, parallel to the joints, and at a distance from them on each side, about equal to the siding of the timbers ; and draw lines, *m q*, perpendicular to the joints ; or, if the frames are opened (54), equalize the openings perpendicular to each of the lines, as *m q*, *m s*, that represent the moulding edges (Note 8), from their intersection with the middle line, to cut the bevelling edges. From, and perpendicular to, the middle line in the half-breadth plan, take the distance to where the bevelling edges cut the horizontal ribbands, and set them off from and perpendicular to the middle line of the body plan, to cut the corresponding diagonals, and draw level lines through them (56) ; then, in the direction of the bevelling edges, and from the lines drawn perpendicular to the joints, *mq*, *ms*, take the distance to each of the horizontal ribbands and set them off from the middle line of the body plan, on the corresponding short level lines just drawn for them : this will give spots for the bevelling edges by the horizontal ribbands. Other spots can be obtained from the level lines &c., the same as for the joints (57), excepting that the distances in the direction of the cant in the half-breadth plan must be taken from the lines drawn perpendicular to the joint, *m q*, *m s*, instead of from the middle line, to give in the body plan the relative position of the bevelling edges with their joints, that the angle formed by the plane of their sides, and the outer surface of the body may be got.

To end the Bevelling Edges. (Fig. 3, Plate II.)

62. Where the bevelling edges in the half-breadth plan cut the half-breadth of the deadwood, square them up to the stepping line in the sheer plan, and transfer the heights to the body plan; then, from the line drawn perpendicular to the joint *mq*, *ms*, where it cuts the middle line in the half-breadth plan, take the distances, in the direction of the bevelling edges, to the half siding of the deadwood, and set them off on the corresponding heights in the body plan: these distances will give the endings.

To obtain the Direction of the Diagonals on the Cant Timbers, and their Heels on the Stepping. (Fig. 3, Plate II.)

63. The stations of the diagonals are determined by drawing horizontal lines from where the projection of the cant timbers crosses the diagonals to the extended cant timbers, and the directions will be obtained by drawing lines from these points, l', to where the diagonals cut the middle line, $l'p'$. To get the direction of the heel on the stepping, square up from the half-breadth plan where the joints of the cant timbers cut the middle line to the stepping in the sheer plan, and transfer these heights to the middle line in the body plan, and draw lines from these heights to the endings of the cant timbers, which will give the direction on the stepping sufficiently correct for all practical purposes, and will also give the lines for cutting off the lower parts of the moulds.

To make the Moulds and take the Bevellings of the Cant Timbers.

64. The moulds for the cant timbers are made as those for the square body (32), each edge of each mould giving a timber and its opposite. The floor mould is in general a batten mould, and when for the common floors, or those that are in one piece, is composed of three parts; one in the middle, equal in breadth to the siding of the deadwood above the stepping, and the other two made to the form of the cant floor that is next to the square body, and formed by battens, the lower batten to the timber, and the upper one sufficiently high at the outer end, that the rising of the other floors may be marked upon the mould, and sufficiently high at the middle to take the cutting down. These two battens are united by cross battens at the heads and sir-marks; and one, with its midship edge at the half-breadth of the deadwood, above the stepping from the middle line, and its lower end well upon the height of the stepping for the outer timber. The mid-

dle piece has marked upon it the middle line and height of the cutting down; it is then placed on the floor for these lines to coincide with corresponding lines got in the body plan, and the two other pieces placed in their proper position; in relation to the cant timber, they are made to, and are united on each side of the middle piece by hinges, that they may be brought to the cant when moulding the piece; upon this mould the head and sirmarks are marked, and the stepping for cutting off the heels of each of the floors is marked on the mould.

65. When the floors are made, the moulds, which are then for the cross piece, are made in two, and jointed in the middle: as the cross piece has only an angle at the middle line, for the ease of uniting them to the half floors, they are batten moulds, with one batten to the form of the timber and one at the upper part, as shown for the common floor (64); these battens are united by cross battens at the heads and sirmarks, and one with its midship edge well with the middle line, which batten is united at the lower part to the one that gives the form of the timber, with a piece placed with its lower edge to the cutting off of the heel of the cant timber, on the stepping; but within the stepping it is formed level. These moulds are made in two parts exactly alike, and united at the middle line by hinges; the height of the cutting down is got upon them, the same as to the common floors.

66. The moulds for forming the floors to the cant, are made to the cant of the timbers, as got in the half-breadth plan (52 and 53), by obtaining it on both sides of the middle line; those for the common floors (64) are made with two angles, one on each side of the middle, equal to the half-siding of the deadwood above the stepping, and those for the cross timbers have only one angle at the middle line; they are made in general very light, being only a batten from three to four inches in breadth. (Note 9.)

To cross the Cant Timber Moulds.

67. The heads and sirmarks, height of top and main breadth, port-sills, and as many level lines as may be necessary for bevelling spots, are marked upon the moulds; the stations of the heads and sirmarks are got as before explained (63), and the heights of the main and top breadths and port-sills, as obtained for getting in the joints (56); the moulds for these timbers are made to the same heads as the moulds for the square body (31), except that the lower timbers before and abaft the floors extend in general to the head, above the cross timber in one case and the common floors in the

other, and sometimes the half floors and timbers above are in one: these timbers are then called double futtocks. Upon the double and lower futtocks is marked the direction of the stepping (30) for cutting off their heels in and out, also a line parallel to the middle line, at a distance from it equal to the distance of the stepping line, taken in the direction of the cant of the timber from the middle line of the half-breadth plan; this line gives the cutting off of the heels up and down, and when the moulds are not sufficiently wide to give the direction of it with any certainty, a spiling is given to it at some distance up the moulds: the heights of the cutting down are likewise given on these moulds for forming the inside of the timbers.

To take the Bevellings of the Cant Timbers. (Fig. 3, Plate II.)

68. The bevellings of the cant timbers are obtained by taking the shortest distances between the curves got in for the joints and bevelling edges in the body plan, at the heads, sirmarks, level lines, port-sills, main and top breadths, and topside; and at as many other places as may be necessary; and by setting off above or below a square, according as the bevelling edges are within or without the joint in the body plan, as *l x*, on a board equal in breadth to the distance between the joint and bevelling edge in the half-breadth plan. The bevellings thus obtained are transferred to a board, in breadth the same as the siding of the timber, and similar to those for the square body (41), excepting that the stations of the bevellings are marked in the margin, and the name of the timber in the circle. The bevelling on the stepping is obtained by squaring up from the half-breadth plan where the joint cuts the stepping, and drawing a line upwards, perpendicular to the keel, as *c d*; then, the stock of the bevel is applied against this line, and the tongue to the stepping, forward for the foremost timber, and aft for the aftermost. The bevellings for the heel against the deadwood are got by applying the stock to the joint in the half-breadth plan, and the tongue to the deadwood.*

On Laying off the Transoms. (Figs. 1 and 2, Plate I.)

69. The transoms that give the form of that part of the ship called the buttocks, require a process in the laying them off according to the position and form of their upper surfaces, which is governed according

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* The stock of the bevel for the bevelling *on the stepping* is applied parallel to the heel up and down; and *against the deadwood*, perpendicular to the heel, up and down.

to their situation. The wing, as it forms the basis of the stern, has the round-up of the lower part of the stern, and was formerly placed to the sheer of the ship; the deck transom receives the after ends of the deck, and must therefore be to the round-up and sheer of the deck; and the transoms below (to assist the conversion), when there is considerable rake, are frequently placed perpendicular to the rake of the post: this takes place mostly in small vessels; when the stern-post rakes but little, the transoms are horizontal. These positions will require three different methods of laying off; namely, when they have a round and sheer, when square to the post or plane of their surfaces canted upwards from the post, and when horizontal.

To lay off a Round-down and Sheer Transom. (Figs. 1 and 2, Plate I.)

70. Before the transoms are laid off, the projection of the margin and upper side of the wing transom, the line at the height of the wing transom at the side (22), buttock lines, stations of several of the square timbers, and the cant of the fashion-pieces (53), are transferred from the half-breadth plan, so as to have them on both sides of the middle line, to some convenient space upon the floor, which is called for distinction the plan of the transoms. (Fig. 2.) In the sheer plan (Fig. 1), draw a vertical line, PR, from the aft side of the wing transom at the upper part, and produce it down to the middle line of the half-breadth plan, where it will likewise cut the aft side of the transom, and draw a line, PR, to correspond to it in the plan of the transoms. (Fig. 2.) Upon the foreside of the rabbet in the sheer plan, set off the stations of the transoms, and draw lines through them to the sheer, and produce these for the upper part, to cut the line PR; because, from this line all distances are taken, and set off from the corresponding line in the plan of the transoms, to keep them in their relative position, and more distinct.

To lay off the Upper Edge of the Transoms.

71. Where the stations of the upper sides of the transoms cut the fore edge of the rabbet in the sheer plan, project them to the outside of the post in the body plan, and from them describe arcs of circles, *t q*, for the round-down square to the sheer, and draw the level lines, *t v*, as tangents to them; then, in the sheer plan, draw a line, *z m*, perpendicular to the sheer of the transom, where it cuts the line PR; and take from the body plan, at each buttock line, the distances from the level line, *t v*, to the round-down, *t q*, and set them off in the sheer plan, from the sheer of the upper part of the transom upon the line *z m*, and then draw parallel to the sheer a line, through each distance, to cut its correspond-

ing buttock lines: a curve passed through the intersections thus obtained by these lines with their respective buttock lines, will give the round-down below the sheer in the sheer plan. Then, from the sheer plan project where this curve cuts the buttock lines and stations of the square timbers, to the corresponding square timbers and buttock lines in the body plan; a curve passed through these projections, and intersecting with the line *t v*, at the half-breadth of the post, will give the round-down and sheer in the body plan. To obtain the form that is necessary for moulding the transoms, the surface must be expanded, as the mould when applied is bent upon the round. In the body plan, take the distance, round the curve, *t q*, form the middle line to each of the buttock lines, and set them off from the middle line in the plan of the transoms; this will give the new buttock lines, at a greater distance from the middle line by the expansion, and if all transoms, that have a round, are of the same round-up, these new lines will answer for the whole. Take from the sheer plan the shortest distances from the line *z m*, to where the round-down below the sheer cuts the buttock lines, and set them off from PR, on the corresponding new, or expanded, buttock lines in the plan of the transoms (Fig.2); a curve passing through these distances will give the form of the upper part of the transom. To end them at the middle, take from the body plan the distances from the middle line to the outside of the post and inside of the rabbet, at the height of the upper side of the transom, and set them on each side the middle line, in the plan of the transoms; draw lines, parallel to the middle line, through them; then, from the sheer plan, take the shortest distances from the line *z m*, to the foreside and middle of the rabbet, and set them on the lines just obtained in the plan of the transoms, for the inside of the rabbet and outside of the post; that for the middle of the rabbet on those for the inside, and the one for the foreside of the rabbet on those for the outside of the post. The curves will end, on each side, upon one of the distances thus obtained; if the curve passes within the spot for the outside, it will end at the middle of the rabbet, if not, at the outside of the rabbet.

To correct the Form of the Transom by the Square Timbers.

72. Take from the sheer plan the shortest distance from the line *z m*, to where the round-down below the sheer cuts the stations for the square timber, and set it off in the plan of the transoms (Fig. 2) from the line PR, and draw a parallel line through it; then, where, in the body plan, the sheer below the round-down cuts the square timber, project it up to the round-down, that is, square to the sheer, and take the distance to it, from the middle line, round the curve, and set it off from

the middle line, on the line just obtained in the plan of the transoms. This distance will correspond with the curve before got in by the buttock lines; and a distance may be thus obtained for as many square or proof timbers as fall within the limits of the transoms.

To lay off the Fashion Pieces and correct the Transoms by them.

(Fig. 1.)

73. The fashion-pieces are laid off in the same way as the cant timbers (56), always making the after edge of each fashion-piece the moulding edge, and laying them off as single timbers. A curve is always got in for the projection of the fashion-piece in the body plan, which is in general distinguished as the square fashion-piece, while the curve that is extended for making the mould is commonly called the cant fashion-piece. The disposition or projection of the fashion-piece is likewise got in the sheer plan, by squaring up from the half-breadth plan where the cant of the fashion-piece in the half-breadth plan cuts the buttock and level lines, and main breadth lines, to the corresponding lines in the sheer plan.

74. To correct the transoms by the fashion-pieces, square up from the half-breadth plan where the buttock lines cut the cant of the fashion-piece (53), and where they cut the middle line to the line (29) for the sheer at the middle; and produce, in the sheer plan, the lines got in for obtaining the round-down below the sheer, to cut their corresponding lines just squared up, and produce the sheer at the middle of the transom to cut the line squared from the intersection of the fashion-piece with the middle line: a curve passed through these intersections will give the projection where the surface of the upper side of the transom cuts the plane of the fashion-piece. In the half-breadth plan, take the distances from the middle line, in the direction of the cant of the fashion-piece, to each buttock line, and set them off from the middle line in the body plan, and draw lines, *s v*, parallel to the middle line; then, in the sheer plan, where the sheer lines got in for obtaining the round-down below the sheer, for each buttock line, cut the curve for the projection of the upper surface of the transom with the plane of the fashion-piece, project them into the body plan, upon the corresponding lines, *s v*, just drawn; and where the sheer line for the middle of the transom cuts the line squared up from the half-breadth plan, for the intersection of the cant of the fashion-piece with the middle line, project it on the middle line of the body plan, *t*, and project likewise where the round-down below the sheer cuts the disposition of the fashion-piece, upon the cant fashion-piece in the body

plan: a curve, *t v v*, passing through all the spots thus obtained will give, in the body plan, the projection of the surface of the transom, with the plane of the fashion-piece. Now, to get the fashion-pieces extended by the sheer and round, and correct the transom by them, take from the sheer plan the distance from the line *z m*, to where the sheer lines for getting the round-down below the sheer cut the curve for the projection of the upper surface of the transom, *q b f*, with the plane of the fashion-piece, and set it off from the line P R on the corresponding new or expanded buttock lines; in the plan of the transoms, take the same for the sheer of the middle of the transom, *q*, and set it off on the middle line, and draw a line through the distance thus obtained: this will give the fashion-piece extended in the plan of the transoms. Then, take from the body plan the distance from the middle line, round the curve, for the projection of the upper surface of the transoms to the cant fashion-piece, and set it off from the middle line in the plan of the transoms on the line for the extended fashion-piece: the distance thus obtained should correspond with the curve got in for the transom.

To lay off the Bevelling Edge of the Round-down and Sheer Transoms.

75. The lines run off for the lower edge of these transoms, will only be for giving the form for the counter moulds; as the bevellings will be taken from the buttock lines in the sheer plan, being more easily applied when taken in this manner. To obtain the lower edge of the transoms, the same progressive manner is pursued in getting the round-down and sheer, in the body and sheer plans, as for the upper edge (71); and for getting their form in the plan of the transoms, all distances are taken from the same line, *z m*, in the sheer plan, and set off from P R in the plan of the transoms, and the ending and corrections by the square timbers are got as for the upper edge, taking all the distances in the sheer plan from the line *z m*, and setting them off from the line P R, in the plan of the transoms.

On the Wing Transom. (Figs. 1 and 2, Plate I.)

76. The lines at present got in for the aft side of the wing transom in the plan of the transom, are only a projection; but, to make the mould, they must be expanded to the round and sheer; therefore, take the distances in the body plan from the middle line round the curve, N *m o*, which is perpendicular to the buttock lines, and set them off from the middle line in the plan of the transoms, which will give new or extended buttock lines there; but should the wing transom have

the same round-up as the transom before laid off (71), the extended lines as there obtained will answer for it. Then, in the sheer plan, take the shortest distance from the line E *m*, to where the lines drawn parallel to *x i* cut the curve E *o i*, and set them off from the line P R, in the plan of the transoms, on the new or extended buttock lines: a curve passed through the distances thus obtained will give the aft side of the wing transom for making the mould to. To obtain the end of the wing transom at the side, take the distances in the sheer plan, from the line E F to where each square timber cuts the sheer line E *e*, and set them off on the middle line in the body plan, below the line N F, and describe from them curves parallel to the vertical round-down to cut their respective square timbers; then, project these intersections upon the corresponding square timbers in the sheer plan, which will give spots for the round-down below the sheer, or where the upper surface of the transom cuts them. To get the end of the transom in the plan of the transoms, take the shortest distances from the line E *m*, in the sheer plan, to where the upper surface of the transom cuts the square timbers, and set them off from the lines P R, in the plan of the transom, and draw lines, parallel to P R, through them; then, in the body plan, square up where the curves described parallel to the vertical round-down cut the square timbers to the round-down square to the sheer, and take the distances from the middle line round this curve, and set them off from the middle line in the plan of the transoms on their corresponding lines just drawn: a curve on each side passing through these distances, and ending where the extended buttock line, *i*, at the extremity of the transom, cuts the aft side of the transom expanded, will give the line for the end of the transom at the side of the ship, or abaft the fashion-pieces.

To make the Moulds and take the Bevellings of the Round and Sheer Transoms. (Plate I., Figs. 1 and 2.)

77. The moulds for the round and sheer transoms are in general batten. They are made with one batten to give the form of the after edge, and another to give the moulding of the transom; they are connected by cross battens, placed at each buttock line, middle line, side of the post, and to the end against the fashion-piece; the last is always without the line for the fashion-piece in the plan of the transom, as much as the fashion-piece lets into the transom.

78. To obtain the fore side of the transom in the plan of the transoms, the moulding of the fashion-piece which corresponds with the moulding of the other part of the frame, is first got in the body plan, and the throating of the transoms in the sheer plan.

The plane of the side of the fashion-piece not being square to the body, the moulding is obtained correctly from the bevellings, as upon the bevelling board ; each bevelling gives a section perpendicular to the surface of the body, at its corresponding place. Draw upon the bevelling board, parallel to the bevellings of each head and sirmarks, if required, lines at a perpendicular distance, equal to the common scantling of the different heads and sirmarks, and take the distance between them in the direction of the side of the board, which is the direction of the plane of the side of the fashion-piece, and set them off, perpendicular to the curve, at their corresponding places, from the outer edge of the cant fashion-piece, in the body plan, and draw a curve for the inside, which will give the correct moulding of this timber to correspond with the common moulding of the frame. Then, in the body plan, at the intersection of the upper surface of the transom with the plane of the fashion-piece (74), or the crossing of the end of the transom upon the fashion-piece mould, take, in the direction of the crossing, the moulding of the fashion-piece, for each transom, and set it off from the corresponding transom, upon and in the direction of the fashion-piece in the plan of the transoms, which will give the moulding of each transom at the end. To get the throating of the transoms, determine it first for the wing and lower transom: the wing is in general given, and it is obtained for the lower transom by drawing in the foreside, fixing the size at the ends as got for the fashion-piece, so that the arms may have a proper degree of substance, and so as not to cut the growth of the timber; and draw in from the throatings thus determined, a line for the throating of the intermediate transoms; then, transfer, from the sheer plan, the throating of each transom to the plan of the transoms, and draw a line for them, making the throating parallel as much as the sternson is sided, and from the moulding obtained from the fashion-piece for the end of the transoms to this line, draw the foreside of each transom, to follow, as near as possible, the aft side, excepting for the deck transom, where the moulding is left as large as the timber can be got for fastening the deck.

79. The breech, or after part of the transom moulds, to the breadth of the post, is made to the bearding of the post, which is first got in the sheer plan ; take the distances where the half breadth of the sternpost cuts the after and upper edges of each transom in the plan of the transoms, from the line P R, and set them off from P R, in the sheer plan, upon the lines for the upper part of the corresponding transoms, and square up where the half-breadth of the post in the half-breadth plan cuts each water line, to the corresponding water lines in the sheer plan, and draw a curve for the bearding of the post; from the

curve thus obtained, the distance that the transoms are to be let on is got, as well as the distance that the transom mould will be made aft; where it will be straight across to the breadth of the post for the breech.

80. The round-up moulds are made sufficiently long to reach across the transom, and to the round-up that is square to the sheer; they are in general formed of one piece as to breadth. (Note 11.)

81. The buttock lines, side of the post, which the cross battens conform to (77), middle line, and what the transoms let into the fashion-piece, are always marked upon the moulds.

82. The bevellings for the round-down and sheer transoms are taken from the buttocks lines, as it would cause considerably more trouble to take them so as to be applied square to the surface of the body; and if they were so applied, it could not be done with more certainty.

83. For the wing transom, the bevelling for the margin, which is the same the whole extent of the transom, is taken by placing the stock of the bevel to the sheer of the transom, and the tongue to the fore side of the rabbet of the post. Below the margin, it is taken at each buttock line, by placing the stock to the sheer and tongue to the buttock lines, and when applied at the transom, the stock is placed to the direction of the buttock lines, as given on the mould, and tongue vertical (Note 12); for the end against the aft side of the fashion-piece, the bevelling is taken to the sheer line E *e*, and against any vertical line, and applied with the stock fore and aft, or parallel to the buttock lines, and tongue vertical; and for trimming that part of the transom at the end that takes the form of the body with the fashion-piece, a short mould is in general made to the crossing of the transom on the fashion-piece mould, *t v v*, and to conform to its moulding edge of the cant fashion-piece, as far down as the depth of the transom, which is applied upon the end of the transom after it is cut off.

84. The bevellings for the transoms below the wing that have a round-down and sheer, are taken and applied the same as the bevellings for the wing, below the margin; and the bevellings for the throat of each transom are taken from the sheer line of its corresponding transom, and to the line got in for the throat, for the breech to the bearding of the post, and applied in a fore and aft direction.

To lay off a Transom, when the Plane of its upper Surface is Canted upwards, or square to the Rake of the Post. (Figs. 1 and 2.)

85. Draw in the sheer plan a line, *rp*, at the station of the transom, for its upper surface, canted upwards as may be necessary, to bring it as near as possible perpendicular to the body; then, take the distance from the line P R, in the sheer plan, in the direction *rp*, where its upper surface cuts each buttock line, middle and fore side of the rabbet, or bearding of the post, and set them off on their corresponding lines, from P R in the plan of the transoms, and pass a curve through them.

86. To prove this curve by the square timbers and fashion-piece, project from the sheer plan where the line *rp* cuts the square timber, buttock lines, middle and fore side of the rabbet, to their corresponding lines in the body plan; and where it cuts the disposition of the fashion-piece in the sheer plan to the square fashion-piece (73) in the body plan, and draw a curve, *s t v*, through these projections for the disposition of the transom in the body plan; and take from P R in the sheer plan, in the direction *rp*, the distance to each square timber and disposition of the fashion-piece, and set them off from P R in the plan of the transoms, and draw in lines parallel to it. Take, likewise, from and perpendicular to the middle line, the distances to where the disposition of the transom, *s t v*, in the body plan cuts each square timber and square fashion-piece, and set them off from the middle line in the plan of the transoms, on the corresponding lines before drawn parallel to P R: these distances should correspond with the curve before obtained by the buttock lines.

87. To prove the spot on the fashion-piece, as obtained by the square fashion-piece in the body plan and disposition in the sheer plan, square up from the half-breadth plan where the cant of the fashion-piece cuts the middle line, to the line *rp* in the sheer plan, and project the height where this squaring up crosses the line *rp*, to the middle line of the body plan; then, where the disposition of the transom cuts the square fashion-piece, square it out to the cant fashion-piece, *t o*, and from its intersection to the spot just obtained upon the middle line draw a straight line, *g o*, which line will give the crossing of the transom upon the fashion-piece mould; next take the distance from the line P R in the sheer plan, in the direction *rp*, to where the intersection of the cant of the fashion-piece with the middle line of the half-breadth plan was squared up to it, and set it off from P R on the middle line in the plan of the transoms; and from this spot to the spot before obtained from

the square fashion-piece, draw a line, *g m*, which will give the end of the transom against the fashion-piece, or cutting off of the transom mould in the plan of the transom. Take, likewise, from the body plan the distance from the middle line, in the direction of the line, *g o*, to the cant fashion-piece, and set it off from the middle line in the plan of the transom, on the line, *g m*, just obtained, which gives the end of the transom: this distance should agree with the spot before got from the square fashion-piece, and through which the curve for the transom was drawn.

88. To lay off the bevelling edge, draw below the line *r p*, parallel to it, as much as the transom is sided or deep, a line $r' p'$ for the lower side, and where the line *r p* cuts the line P R, draw a line $r r'$ downwards perpendicular to it; and lay off the lower edge the same as the upper, excepting that all distances are taken from $r r'$ in the sheer plan, instead of from P R.

89. The moulds for this transom are made the same as for the round-down and sheer (77), taking the distance of the throating (78) and breech (79) from P R in the sheer plan, in the direction *r p*, and the moulding of the ends from the fashion-piece mould, in the direction of the crossing (87).

90. The bevellings are got by taking the shortest distances between the moulding and bevelling edges in the plan of the transoms (at as many places as may be necessary, marking where they are taken upon the mould), and setting them off on a board, in breadth equal to the depth of the transom, above or below a line squared across it, according as the bevelling edge is within or without the moulding (68). The bevellings taken in this manner are applied square to the curve. For the end against the fashion-piece, the bevelling is taken from the line *rp*, and to any vertical line, and applied with the stock in a fore and aft direction; for the breech, to the line *rp* and to the bearding of the post (79), and for the throat, to the line *rp* at the line for the throating.

To lay off the Horizontal Transoms. (Figs. 1 and 2.)

91. These transoms will be represented, both in the sheer and body plans, by horizontal lines, or lines parallel to the keel, *d d*. Draw the upper side of the upper transom, in the body and sheer plans, at the same height, so as to be well with the lower side of the deck transom at the fashion-piece, and below it draw the lower side, according to the depth of the transoms, and below this transom, with proper openings between them, as many transoms as are intended to be given.

92. In the body plan, take the distance from the middle line, at the upper and lower edges of each transom, to the siding of the post and inside of the rabbet, and set them off on each side of the middle line, in the plan of the transoms, and draw lines through them parallel to it. Then, from the sheer plan, take the distances from the line P R, to the middle of the rabbet, bearding of the stern-post (79), and to each buttock line, and set them off on their corresponding lines, from the line P R in the plan of the transoms, and draw curves through them for the upper and lower edges of each transom; and to prove these curves, take the distances from the middle line of the body plan, where the upper and lower sides of each transom cut each of the square timbers, and set them off from the middle lines, on their corresponding square timbers in the plan of the transoms: these spots should answer to the curves before drawn in.

93. The moulds for these transoms are made the same as the other transoms (89). For all the transoms counter moulds are in general made to the bevelling edges, for moulding the lower sides; and are made on one side only, of one single strip with one end to the middle line.

94. The bevellings for these transoms are taken and applied the same as to the transom with the plane of its side canted upwards (90); except their ends against the fashion-piece, which will be square, as they lie horizontal.

To lay off the Round Aft Tuck. (Figs. 5 and 6, Plate III.)

95. The tuck is that part of the after extremity of the ship which bounds a great portion of the planking. When the form of the buttocks terminates in the wing transom, a rail, called the tuck-rail, forms the boundary; but when the buttocks are limited by an athwartship timber, with its aft side in the same plane as the after edge of the rabbet of the post, the planks ending in a rabbet taken out of it, the ship is said to have a square tuck. And when this timber, instead of its after side being athwartships, is a portion of a cylinder, with its axis parallel to the after part of the rabbet of the post, it is called a round aft tuck.

96. In order to lay off the round aft tuck, draw, in the sheer plan, the after edge of the rabbet of the post, and the round-down and sheer

of the transom, and draw, in the body plan, the upper part of the transom and the half-breadth of the post; and proceed to obtain the projection of the timber in the half-breadth plan. Draw in the sheer and body plans, a level line at the height of the wing transom at the side; and below it, at about two feet apart, as many others as may be considered sufficient to draw in the timber, running them all off in the half-breadth plan. To end these lines, get in the first horizontal round-forward of the upper level line, which may be done by means of the round-forward square to the axis; draw in the sheer plan, a line square to the rabbet of the post, cutting the round-forward of the transom at the upper level line, as *a o;* square down the point *o*, to the corresponding level line in the half-breadth plan; at the intersection draw to the middle line, and perpendicular to it, a straight line, and set off abaft it, upon the middle line, the distance *o a*, taken from the sheer plan, and describe from this spot to where the straight line cuts the level line in *l*, by the common methods, the circular arc, *k l*. In the half-breadth plan, draw the buttock lines, *d d*, *d d*, one at the breadth of the wing transom, and as many others, about two feet apart, as its breadth will allow, and take their distances from the straight line just drawn to their intersections with the circular arc *k l*, and set them off to the after edge of the rabbet on the line *a o*, in the sheer plan, and draw through the spots the lines *o q*, parallel to the rabbet of the post; and where they intersect the level line *o c*, square down to their respective buttock lines in the half-breadth plan, and draw through the spots the elliptical curve *h l*, which will be the horizontal round-forward at the level line, *o c*. Then, where each level line in the sheer plan cuts the after edge of the rabbet of the post, square down to the half-breadth of the post out from the middle line in the half-breadth plan, which half-breadth is obtained from the body plan; from these spots draw the curves, *g h*, parallel to the horizontal round-forward already obtained, so as to cut their respective level lines in *h*, which intersections give their endings, through which passes the curve *l' h' h' h'*, which gives the tuck's projection in the half-breadth plan.

97. To obtain the projection of the tuck in the body plan, take the distances square to the middle line, where each level line in the half-breadth plan cuts its round-forward, and set them off on their corresponding level lines in the body-plan; pass a curve through the spots, which will form a fair line, if the endings in the half-breadth plan are correct; if they are not, the endings of the level lines at the points *h*, must be altered, till the projection is fair.

98. To prove the tuck by buttock lines, draw them in the body plan,

at the same distance from the middle line as they are in the half-breadth plan, and run them off in the sheer plan (24); where they intersect, their corresponding lines, *o q*, will be their terminations; and if a curve be drawn through them, it will be the projection of the tuck in this plan; if it be right, the buttock lines will correspond with their intersections with the level lines squared up from the half-breadth plan; and the endings of the buttock lines in the sheer plan will, at the same time, agree with their intersections with the tuck of the body plan.

92. The body being thus proved by horizontal and vertical sections, it may next be proved by diagonal lines. Draw in the body plan the places of the diagonals, according to the heads and sirmarks, and run them off in the half-breadth plan (20), ending them by transferring the point in which each diagonal cuts the projection in the body plan, as at *k*, to the projection in the sheer plan, and square down their intersections to the middle line of the half-breadth plan, and draw out lines perpendicular to the middle line; then, take from the body plan the distances, in the direction of the diagonals, from the middle line to the projection, and set them off respectively on the lines first drawn. But to obtain the termination of the diagonal plane at the after part of the tuck, square down where the buttock lines cut the after and upper edge of the transom, *q q q*, in the sheer plan, to the corresponding buttock lines in the half-breadth plan, and through the spots draw the curve *d s t*, which is a projection of the upper and after edges of the transom in this plan. Now, take the distance square to the middle line, to where the diagonal cuts this after and upper edge in the body plan, and set off square to the middle line of the half-breadth plan, so as to cut the curve *s t*, and there square out the line *o v*; upon it set off the diagonal distance taken from the middle line of the body plan, to the upper edge of the transom; and to obtain the intermediate spots for the round-aft of the diagonal section, proceed in the same manner with the different level lines. Spots may be obtained also for the round-aft of a diagonal plane by means of the buttock lines, by transferring the height of the intersection of the diagonal with the buttock lines in the body plan, to the corresponding buttock line, *o q*, in the sheer plan, and square it down to the half-breadth plan; take the distance in the body plan, from the middle line to where the diagonal cuts the buttock line in the diagonal direction, and set it off from the middle line of the half-breadth plan on the line squared out; through these different spots draw the curve *v m*, which gives the termination of the diagonal plane.

100. When all the corrections are obtained by the horizontal, vertical, and diagonal sections, the timber may be brought into a vertical position, and expanded for the purpose of making the mould. In transforming this timber from its projection to a vertical position, it is necessary to fix upon some point through which the axis of revolution must pass; let this be the point *x*, which is where the projection in the body plan cuts the stern-post. Transfer this height to the after edge of the rabbet of the post in the sheer plan, and draw the line *n i*, perpendicular to the rake; from *n i*, take upon the rake of the after edge of the rabbet of the post, the height of all the level lines, setting them up from *x y*, on the middle line of the body plan; and from where the level lines in the sheer plan cut the projection, *o o o*, take their shortest distances from the line *n i*, setting them off in the body plan, and draw short level lines through them; take, likewise, from the half-breadth plan the distances round the horizontal round-forward, from the middle line to the intersection of the tuck's projection with each of the level lines; and then upon the heights corresponding to them in the body plan, set off these distances, that is, by placing the spot on the batten denoting the middle line of the half-breadth plan well to the corresponding height *w*, on the middle line of the body plan, the other spot on the batten being made to cut the corresponding height *u d*, or short level lines just drawn, in some point, *z*, which will give a spot for the thrown up or expanded tuck. But as all lines formed by planes cutting a cylinder obliquely to its axis are curves upon the expanded surface, this method of applying the batten, viz. in a straight line, cannot be correct; it is, however, sufficiently near for all practical purposes; for the portion of the arc is so small in proportion to the radius, that the curve becomes insensible. But should the round-forward be such as to give any sensible curvature, the intermediate spots can be obtained as follows: take the distances of the buttock lines from the middle line of the half-breadth plan, round the curve *k l*, which is the round-forward perpendicular to the axis, and set them off perpendicular to the middle line of the body plan, and there draw perpendicular lines, which will be the buttock lines thrown out by the expansion of the surface. In the sheer plan, take the shortest distances from *n i*, to where the buttock lines, *o q*, cut the level lines, and set them off in the body plan above *xy*, upon the buttock lines just expanded; these spots will give the curvature between *z w*, to which the before-mentioned batten should be applied when setting off the distance *z*; this method being repeated for every level line, will give the true expansion of the tuck by horizontal sections.

101. To obtain the expansion of the tuck by the buttock lines, take

the shortest distances from the line *n i*, to where the buttock lines, *o q*, cut the projection in *o o*, setting them off in the body plan above *x y*, on the corresponding expanded buttock lines: a curve drawn through these spots will give the timber by vertical sections.

102. To lay off the timber by diagonals, transfer the height where each diagonal cuts the projection in the body plan to the projection in the sheer plan; take the shortest distances of these heights from *n i*, and set them above *x y* in the body plan, drawing horizontal lines through them; now take the distances square to the middle line of the body plan to where the diagonals cut the projection, and set them off square to the middle line of the half-breadth plan, so as to cut the perpendicular round-forward *k l;* take the distances of these spots from the middle line round the curve, and set them off in the body plan upon the corresponding horizontal lines just drawn. A curve passed through these spots will pass through those obtained by the vertical and horizontal sections, and will be the form of the timber expanded and thrown into a vertical position, and would be the right curve to make the mould to in order to trim the fashion-piece, provided the outer service was intended to be well or in the same surface with the timbers of the frame; but, as it is necessary to have a stop for the hooding ends, a rabbet must be taken out of the fore side of it to receive them; the outer surface must therefore coincide with the outer surface of the exterior planking, consequently the fashion-piece must be trimmed throughout to it, and the rabbet must be taken out afterwards.

103. To obtain the thickness of the plank from the timber lines, run in a proof timber so near to the projection of the tuck, that the round between them may be inconsiderable. Where the horizontal lines cut the projection of the tuck in the half-breadth plan, draw lines parallel to the middle line, cutting the proof timber as shown by *h l;* in the body plan, take the shortest distance from the projection of the tuck to the proof timber at each level line, as $o'q'$, and set it off in the half-breadth plan on the proof timber, above *h l*, as denoted by *i;* now draw the line ip', and above it, on the next timber, set off the shortest distance from the body plan of the proof timber from the timber before it, then, from where the back of the arc described in taking the shortest distance between the tuck and proof timber, cuts the proof timber; this distance set off is denoted by s': through these spots draw the curve *s i h*, which will be the form of a section square to the body. In the body plan, draw the line $q'\,o'$, passing through the intersections of the arcs with the timbers, described in taking the shortest distance, to the

next level line above, as at *n*, and square a line, *o m*, up from its intersection with the level line at the tuck, to the one above, and take the distance, *mn*, and set it off in the half-breadth plan below, *hl*, produced aft so as to cut the round-forward of the corresponding level line, and square a line towards the middle line. Then, from the body plan take, in the direction of the diagonal *o n*, the distance between the level lines, and set it off on the line just drawn in the half-breadth plan below *hl*, as *x*, and draw the line *x h*, which gives the form of the square section on the round aft; now, draw in the half-breadth plan, parallel to the curve *his*, the curve *fg*, to the thickness of the bottom plank from it; produce the line *x h*, so as to cut it in *f*, and this gives the distance *hf*, to be set off in the body plan from the timber line expanded, which will give one point for the exterior surface, that is, for the outside surface of the planking. However, before the distance *hf* can be set off in the body plan, it is necessary to throw up into a vertical position and to expand the line *oq*, on which it is to be set off; therefore, transfer the point *o*, which is where the level line cuts the projection, to the projection on the sheer plan, from which point take the shortest distance from *ni*, and set it off in the body plan on the middle line above *x y*, and there draw a level line; from the body plan take the distance from the middle line to where the diagonal *o n* cuts the projection of the tuck, and set it off upon an athwartship line, so as to cut the square round aft; then, in the half-breadth plan, take the distance of this spot round the curve to the middle line, and apply it from the middle line in the body plan on the level line last drawn, which gives one spot for the line *o′q′*. Another may be obtained by transferring from the body plan where *o′q′* cuts a buttock line to the corresponding buttock line in the sheer plan, and then proceeding exactly as for the other spot; by this means any number of spots may be obtained, through which a line being drawn gives the degree in which to set off from the expanded timber line to the line *hf*. This being repeated at every level line cutting the projection (or nearer, if thought necessary), and a curve being drawn through the different spots so obtained, gives the curve coinciding with the exterior surface of the planking.

To lay off the Fore Edge of the Tuck.

104. To trim the fore edge of the timber correctly, it becomes necessary to make a counter mould, to obtain which the fore or bevelling edge of the timber must be laid off to make the mould to. In the sheer plan, draw the line AB parallel to the fore edge of the rabbet of the stern-post and at the distance of the siding of the tuck timber from it;

square down the intersections of this line with the level lines, to the middle line of the half-breadth plan, and from these points draw horizontal rounds-forward, $g''h''$, parallel to the former ones : a curve being drawn through the intersections of these curves with their respective horizontal sections, gives the projection of the fore edge of the tuck in the half-breadth plan ; which, squared up to the respective lines in the sheer plan, gives the projection there.

105. The projection being obtained in the half-breadth and sheer plans, the fore edge may be immediately run off in the body plan in its vertical position, there being no necessity for first getting in the projection, as was the case with the after edge. Take the shortest distances in the sheer plan to where each level line cuts the projection of the fore edge, and set them off in the body plan above X Y ; take likewise their distances round the curve, from the middle line to where each horizontal section or round-forward cuts its respective level line, and set them off in the body plan, on the heights just obtained there, in the same manner as was pursued for the after edge: a curve being drawn through the spots, gives a line flush with the timbers, or well to the interior surface of the planking; which, as subsequently shown, is sufficient for the counter moulding, without putting on the plank, as has generally been the practice. The fore edge being thus obtained, may be proved by the vertical and diagonal sections, in the same way as was done for the after edge.

Moulds for the Fashion-Pieces of the Round Aft Tuck.

106. The round aft mould is made to the line *kl*, which is the round aft square to the axis ; this mould is applied to the piece square to the middle line, and the piece is trimmed through in lines parallel to the axis, that is, in the direction of buttock lines. The mould for trimming the fashion-piece to its form as a timber, is made to the vertical position of the after edge, to the line got in for the exterior surface of the planking; cutting off the lower end to X Y, the midship edge to the middle line, and the upper part to a line obtained as follows :—From the sheer plan take the shortest distances above *ni*, to where each buttock line and the after edge of the rabbet cut the upper and after edges of the transom, and set them off in the body plan, upon their respective expanded buttock lines ; a curve passed through these spots gives the upper edge of the transom, to which the fashion-piece mould may be cut off. The lines *qon*, as obtained for the vertical position of the tuck, must be marked upon this mould, for the purpose of setting off the bevellings; also the places of the sirmarks for the situations of the

harpins; and one of the lines at *w*, which should likewise be marked upon the stern-post mould, for placing them in their proper situations with respect to each other when correcting them. The counter mould may now be made to the vertical position of the fore edge, which is the timber line; the midship edge is cut off to the middle line, and the lower end to X Y; so that, by squaring over XY, and also the middle line, from the aft to the fore side of the fashion-piece, we shall have places for applying the counter mould.

The Bevellings of the Fashion-Piece.

107. When the bevellings are taken from curved surfaces, they are liable to error in their application; therefore, the safest way in this case will be to make small moulds, as *y*, in the half-breadth plan, giving the after and outer surfaces of the timber. This process will perhaps be attended with a little more trouble, which, however, should not be considered, as accuracy is very necessary. Make the small moulds in question to the sections that are run off, square to the body and to their terminations, as *xhfg*. When the timber is moulded on the after side to the exterior surface of the planking, and the stations and directions of the small moulds, viz. the lines *qon*, as obtained for the vertical and expanded position, marked on it, they must be applied to their respective stations, and spots must be dubbed through till they fay to the timber. The thickness of the plank may then be set off on the fore side within the moulds, or from these spots, and dubbed through, by which means spots are obtained for the application of the counter mould, which will give a line on the fore side for taking out the rabbet for the planking; the exterior surface of the timber, viz., to the outside of the planking, is trimmed through first, having penned battens to the spots given by faying the small moulds on the fore side; and afterwards the rabbet is taken out to the counter moulding, and in the direction of the small moulds.

The Transom Mould.

108. The round up mould is made to the round up square to the sheer in the body plan, as S T, which must be transferred to some convenient place, for the means of obtaining both sides.

The round aft mould is formed as follows: Pen a batten upon the curve S T, or round up square to the sheer in the body plan, and mark upon it the buttock lines; then place it straight and square to the middle line, in the half-breadth, and draw new buttock lines at the spots thus given, and take the shortest distances from the line square to the sheer, *q c*, in the sheer plan, to the intersection of the sheer lines, *m q*, with the buttock lines *q q q*, and set them off on their respective new buttock lines in the half-breadth plan, from the line *d d*, and pass a curve, which will give the line to make the round aft mould, to be applied upon the round-down and sheer. This curve must likewise be transferred to some convenient situation, that both sides may be drawn in.

The Bevellings of the Transom.

109. The bevellings are taken by placing the stock of the bevel to the sheer line, and the tongue well to the after edge of the rabbet of the post. In the application of these bevellings, the stock must be kept in a fore and aft direction, and the tongue in a vertical position.

To lay off the square Tuck.

110. The square tuck is used mostly in lighters and boats, as the long boats, launch, &c., and sometimes in larger vessels, to avoid the difficulty of laying off the round aft tuck.

111. In the body and sheer plans, draw in a level line at the height of the upper part of the tuck and below it, and as many others as may be necessary to get the timber in correctly, and run them off in the half-breadth plan. Then, to obtain their endings, square down from the sheer plan, where they cut the after edge of the rabbet, to the corresponding level lines just run off in the half-breadth plan; and to obtain the projection of this timber in the body plan, take the distances from the middle line in the half-breadth plan to the ending of each level line, and set them off from the middle line in the body plan, upon their corresponding lines, and draw a curve in for the projection, which may be proved by the diagonal and buttock lines. The diagonals are drawn in the body plan to the heads and sirmarks, and run off in the half-breadth plan (20), and their endings obtained by transferring the height where they cross the projection of the tuck in the body plan, to the after edge of the rabbet in the sheer plan, and squaring them down to the half-breadth plan; and taking the distance from the middle line of the body plan, in the direction of the diagonal, to where it crosses the projection, and setting them off, on the corresponding lines just squared down, in the half-breadth plan: these will be the correct endings of the diagonals. The buttock lines are drawn in as before explained (98), and run off in the sheer plan; and to obtain their endings, project the heights where they cut the projection of the tuck,

in the body plan, to the after edge of the rabbet in the sheer plan. If the endings of the horizontal, diagonal, and buttock lines, give fair curves in the half-breadth plan, as obtained from the projection of the tuck got in the body, they may be considered as correct.

112. To get the tuck on a vertical plane, for making the mould, draw a level line, in the body and sheer plans, at the height where the projection of the tuck cuts the half-siding of the stern-post in the body plan; then, take the distances from this line, in the direction and at the after edge of the rabbet of the post, in the sheer plan, to each level line, and set them up, above the corresponding line, at the middle line of the body plan, and draw new level lines through them; and where the projections of the tuck, in the body plan, cut the original level lines, square up the intersections to the new level lines just obtained: a curve passing through them will give the tuck thrown up on a vertical plane, or the curve to which the mould is to be made.

113. To obtain the fore or bevelling edge to make the counter mould, draw a line to the siding of the timber in the sheer plan, parallel to the after edge of the rabbet. Then, draw a line in the sheer plan perpendicular to the after edge of the rabbet of the post, at its intersection with the level line before drawn, at the height of the intersection of the projection of the tuck in the body plan with the half siding of the post; and from this line, drawn perpendicular to the rabbet, take the distances, in the direction of the rake, where each level line cuts the fore side, and set them up in the body plan above the line, at the intersection of the tuck with the half siding of the post, and draw level lines through them. Then, square down the intersection of each level line with the fore side, in the sheer plan, to the corresponding level lines in the half-breadth plan, and take the breadth at their squarings down to the middle line, and set them off from the middle line in the body plan, on the new level lines for the fore side, and draw a curve through them for the fore side thrown up on a vertical plane, or for the curve to which the counter mould is to be made.

114. To get the thickness of the plank, if necessary, the same method is pursued as explained for the round aft tuck (103). (*y* Figs. 4, 6.)

To make Moulds and take the Bevellings.

115. The moulds are made as explained for the round aft tuck (106), and the bevellings, if applied square to the surface, are taken the same as for this timber, except that the distance, *m n* (Fig. 5), is not

considered, as there is no round; and the bevellings may be taken, as the surface of the aft side is straight, from the level or buttock lines; or from the level lines, by applying the stock or bevel athwartships and the tongue to each level line, at their endings in the half-breadth plan, and applying them upon the tuck with the stock well to the level line, as marked on the mould and tongue horizontal; and from the buttock lines, by placing the stock to the aft side of the rabbet and tongue to the buttock lines, and applied with the stock to the stations of the respective buttock lines, parallel to the middle line, and the tongue fore and aft.

To lay off the Side Counter Timber. (Figs. 7, 8, 9 and 10, Plate IV.)

116. The projection of the after edge, both in the sheer and body plans, is already got in (26) for ending the lines that were for fairing the topside (28), and from them the lines for making the moulds may be obtained. Draw in the sheer and body plans, as many level lines, with those already got in, as may be necessary, placing one at each knuckle, and one between the upper and lower knuckles, and in the straight parts; making them from two to three feet, and at the lower part, where there is considerable round, from 12 to 18 inches apart; and run them off in the half-breadth plan, and obtain their endings as described (28). Draw, likewise, in the sheer plan, the size of the timber for the fore edge.

117. The side counter timber partakes of the form both of the rake of the stern and of the topside; it requires, therefore, for the convenience of forming the timber both ways, that one mould should give the form; that is, one way, the rake of the stern by its edge, and, the other way, the form of the topside, by the plane of its side, from which, distances, commonly called spilings, are set off. That these distances or spilings, which are to be taken and applied from the plane of the mould, should be equalized as nearly as possible, the mould is inclined inwards at the upper part, so as to touch in two places on the fore part of the timber,—namely, at the main breadth and upper part, or as high up as the mould is to be made.

118. The timber, as already shown in the sheer plan, is only a projection; and will require, to get the curve for making the mould, to be extended on a vertical plane; but as the form of the timber is to be projected upon the plane of the mould, it will only require that this mould, which was inclined to equalize the spilings, should be brought

upon a vertical plane; this is done sometimes by its being made to revolve round an horizontal axis, at the height of the wing transom, at the side, and thrown up in the sheer plan. At other times it is made to revolve round a vertical axis drawn from the heel of the timber at the fore part, and thrown aft.

(Fig. 7.)

119. Square down where each level line and line at the end of the wing transom, in the sheer plan, cut the fore side of the timber, *a a a*, to the corresponding level lines and line at the end of the wing transom, in the half-breadth plan; and, as in the first case, it will be made to revolve round an horizontal axis, take the distances from the middle line in the half-breadth plan, to each level line and line at the end of the wing transom, at the squarings down, and set them off on their corresponding lines in the body plan, and draw a curve through for the projection of the fore edge of the timber. Next, draw in the body plan the line A B, to represent the plane of the mould, inclined so as to equalize the spilings; take the distances from the line C D, in the direction of the line A B, that represents the plane of the mould, in the body plan, and set them off above C D, in the sheer plan, and draw there new level lines, *c c c*; then, in this plan, where the fore and after edges of the timber is cut by the original level lines, square them up to the level lines just drawn, and draw the fore and after edges of the timber to them: this will give the form of the timber thrown on a vertical plane, or the lines for making the moulds to.

120. To cut off the end of the mould on the transom, get in the half-breadth plan a projection of the intersection of the upper surface of the transom with the side, and likewise the round-down below the sheer, or projection of the transom in the body plan (76); then, take the distance square to the middle line, in the half-breadth plan, to where the plane of the aft side of the fashion-piece cuts the projection of the transom at the side, and set it off from the middle line, in the body plan, upon the round-down below the sheer, and project it to the sheer plan, and upon it square up from the half-breadth plan, where the fashion-piece cuts the projection, and draw a line from where the aft side of the timber cuts the line C D, to this spot just squared up, which will be the line for cutting off the end of the mould sufficiently near for practice; but to obtain it correctly, the exact projection of the end between the two points must be got. Mark any number of spots upon the projection for the end of the transom in the half-breadth plan, between the fashion-piece and aft side of the transom, and square

them up to the sheer plan; then, transfer the breadth at each of those spots in the half-breadth plan, to the round-down below the sheer in the body plan, and take their distances below C D, in the direction of the mould A B, and set them below C D on the corresponding lines; last, square up to the sheer plan, and a curve passing through these spots will give the exact projection, or give the correct line for cutting off the lower end of the mould.

121. To cut off the mould against the fashion-piece, take the distances that the line A B, or line for the plane of the mould, in the body plan, are from the middle line, on the level line C D, and at the level line 1, and set them off from the middle in the half-breadth plan, and draw the lines *m n* and *x i*, parallel to the middle line, and produce the cant of the fashion-piece to cut them in *n* and *i*; then, from the body plan take the distance that the level line 1 is above C D, in the direction of A B, and set it off above C D in the sheer plan, and square up, from the half-breadth plan, *n* and *i*, that is, to their corresponding line, and draw a line, *q z*, to these squarings up; this line will give the cutting off of the mould against the fashion-piece.

122. The mould is made to the lines just obtained on the vertical plane, and upon it is marked the level lines and spilings or distances, at each level line, which give the form of the side of the timber from the plane of the mould, when applied to the timber. These spilings are got by taking the distances, in the body plan, that the line A B, or representation of the mould, is from the projection of the fore and after edges, in the direction and at each level line, which are written down at their corresponding level lines, and are always crossed on the mould upon the fore and after edges. To get the spilings at the part of the mould which cuts off against the fashion-piece, square down, in the half-breadth, the points *n* and *i*, from the lines *m n* and *x i*, and take the distances from these lines to their corresponding half-breadth lines, and write the distance on the mould at their respective places.

123. To mould the outside of the timber, a bracket mould, *g*, is made, that the spilings may be correctly applied in the direction in which they are taken,—that is, to the angle formed by the inclination of the mould A B with the level lines. This mould is formed of two pieces, one piece rather longer than the counter timber mould is wide at the widest part, and about a foot wide; the other piece, which may be two feet long, has one of its ends cut off to the angle formed by the

line A B and level lines, and fixed on one side, at the middle of the other piece. To apply the spilings, the counter timber mould is set straight and out of windings upon the piece, and the spilings set off from it, by placing the bracket mould at each level line, and setting up on the fore side, or side of the mould that has the least spiling, a spot to the difference of the two spilings, or what the greater spiling is more than the lesser, and fix a batten to it and to the opposite edge of the mould, and set down on each side, parallel to this batten, in the direction of the bracket mould, perpendicular to the counter timber, the greater spiling. This is done because the timber frequently projects beyond the edges of the mould, and could not therefore be applied directly from the mould; this is repeated at every level line, and spots marked on the piece, and through them a thin batten is made to pass to give the form.

124. Instead of setting the spilings down below a batten, as before described, what is called a span, M, is sometimes used, which is made of three pieces of batten; two of them, the up and down battens, *c c*, at sufficient distances apart, and fixed at right angles to the other cross batten, *d*, to span the piece. This span is placed upon the mould, *a*, and the breadth of the mould marked upon it, at each level line; the span is then taken, and a straight batten placed to the spilings for each respective level line, the edge of which is then marked upon the up and down battens; it is then re-applied on the mould to each level line, with the spots for the breadth of the mould on the cross batten kept to the edge of the mould, and with the up and down battens kept in the direction of the bracket mould; the lines drawn upon them to the spilings are then produced by the pointed battens, *b*, to the piece, which being done at each level line, gives spots for the outside of the timber, as before obtained. The inside of the timber is marked by from it, to the common scantling of the topside.

125. When the piece is trimmed through on the outside and inside, the counter timber mould is re-fixed exactly in the same place as it was in the first instance, and the edges of the mould are projected upon the piece for the fore and after sides. They are projected by drawing a square line upon the bracket mould, which is kept well with the edges of the mould at the level lines, knuckles, &c., and its direction carried from the mould to the piece; the lower end on the transom (120) is likewise projected down to the piece, in the direction of the bracket mould; but the end against the fashion-piece (121) is carried down in the direction of a bevelling taken from *m n i*, in the half-breadth plan,

and to the cant of the fashion-piece; and when applied, the stock is kept on the mould parallel to the level lines, and the tongue in the direction of the bracket mould.

126. When the moulding of the fore and aft edges of the timber is got on the piece, the bevellings of the after edge and lower end are then set off, before the mould is removed. Draw at the ending of each level line (116), in the half-breadth plan, the horizontal rounds-forward; then take the bevelling from these rounds-forward to a fore and aft line, at their intersections with their corresponding half-breadth lines, and apply them by keeping the stock well to their corresponding level lines on the mould, and tongue in the direction of the bracket mould, or by placing the bevellings on the bracket mould, and carrying down their direction by a batten. For the knuckles, draw in the body plan the horizontal round up of each knuckle, and take the bevelling by placing the stock to the line A B, and tongue to the round up, and apply it by placing the stock perpendicular to the level lines on the mould. The bevelling must be taken and applied in the same way for the end upon the wing transom.

(Fig. 8, Plate IV.)

127. When the mould is made to revolve upon a vertical axis (118), the line M O, to represent it, is drawn in the half-breadth plan, so as to equalize as much as possible the spilings at the endings of the level lines. Draw in the sheer and half-breadth plans, the line G H, to cut the fashion-piece at the projection of the end of the wing transom; this line will represent the line upon which the mould revolves when thrown upon a vertical plane.

128. Project perpendicular to the line M O, or the line that represents the mould, the endings of the level lines *c d*, and projections of the end of the wing transom *x*; next square down, from the sheer plan, the fore side of the side counter timber, at each level line, to the corresponding level line in the half-breadth, and square these up in the same manner, $c' d'$. Then, take the distances in the half-breadth-plan, from the line G H, in the direction of M O, to the endings of the level lines, &c. and fore side of the counter timber just squared up to M O, and set them off on their corresponding level lines in the sheer plan, and draw to them, a new fore and aft side of the timber; this will give the timber thrown aft on a vertical plane, and will be the lines to which the mould is to be made. From and perpendicular to M O, or the line of the plane of the mould, the spilings are then taken for the

aft and fore sides of the timber, at the ending and fore side, as squared down from the sheer plan to the level lines, and projection of the end of the wing transom in the half-breadth plan, and written upon the fore and after edges of the mould, at their corresponding places. To cut off the mould against the fashion-piece, produce the cant of the fashion-piece F P, in the half-breadth, to cut the line M O, and take the distance from the line G H, in the direction of M O, to the intersection, and set it off from G H in the sheer plan, and draw a line perpendicular to the keel *o p;* to this line the mould is to be cut off against the fashion-piece. To cut the mould off on the transom, draw any number of lines, *n*, from the projection of the end of the wing transom in the half-breadth plan to, and perpendicular to, the line M O, and take the distances from G H, to where they intersect the said projection, and set them off from G H, upon the projection of the end of the transom in the sheer plan, and mark spots; take likewise their distances from G H, in the half-breadth plan, in the direction of M O, to where they cut M O, and set them off from G H in the sheer plan, and draw short lines perpendicular to the keel through them. Then from the spots before marked upon the projection of the end of the wing transom, draw horizontal lines to cut these short lines, and pass a curve through the intersection: this will give the curve for the lower end of the mould.

129. To mould the outside of the timber, the mould is fixed, and spilings applied the same as before explained (123), except that they are all set off square to the mould, instead of having a bracket mould to give their direction; and after the mould is re-fixed, the edges and knuckles are squared down from the mould to the piece, to give the form of the fore and after sides, except the part of the mould against the fashion-piece, which must be produced to the piece in the direction of a bevelling taken from the line M O, and to the cant of the fashion-piece in the half-breadth plan.

130. To take the bevellings. The bevellings may be taken and applied the same as before explained (126), except that, when taken, the stock of the bevel must be placed to the line M O, in the half-breadth plan, and tongue to the horizontal round aft, instead of being placed to a fore and aft line and horizontal round aft; and when applied, instead of being kept to the raking mould, the stock is kept in the direction of the level lines, and tongue perpendicular to the plane of the mould; but when they are to be applied square to the rake, the process is different.

131. To apply the bevellings square, draw in the sheer plan, from

where the level lines cut the aft side of the projection of the timber, the line, $s t$, perpendicular to the rake; and square down where they cut the fore and after edges of the timber at $s t$, to the line M O in the half-breadth plan, to o and p; and from the sheer plan, take the length of the line $s t$, and set it off in the half-breadth plan, from o, in a fore and aft direction, and draw a short line, perpendicular to the middle line, from MO, through it; draw, likewise, in a fore and aft direction, a line from p, or the squaring down of the fore side of the timber, to this short line; and from the intersection x, draw a line, $o x$, to where the squaring down of the aft side of the timber, o, cuts the line M O; this line will give the inclination of the mould at the intersection of an athwartship plan, perpendicular to the rake. Then, draw the line, $o s$, in the half-breadth plan, perpendicular to the middle line, to cut the endings of the level lines; and, abaft them, at the middle line, set off the square round aft $s v$, taken from the sheer plan, at the intersection of $s t$ with the projection of the timber, perpendicular to the rake, and draw in arcs of circles to cut the endings. To cross the mould, in the sheer plan, draw out, horizontally, lines from where $s t$ cuts the fore and after edges of the timber, to the fore and after edges of the timber thrown aft, on a vertical plane, and draw the line $s' t'$; these lines give the crossings on the mould for applying the bevel.

132. To take the bevellings, place the stock of the bevel in the direction $o x$, in the half-breadth plan, and the tongue to the round aft, and apply the stock upon the mould after it is re-fixed, for moulding the fore and after edges to the crossings. To obtain the bevelling on the wing transom, draw a vertical line at the end, and place the stock to this line, and to the vertical round aft, and apply it with the stock perpendicular to the level lines, and tongue kept athwartships. The bevellings for the knuckles must be taken and applied in the same manner.

To lay off the Midship Counter Timbers.

233. These timbers, which form the rake and support the stern between the side counter timbers, are placed so as to pass between the lights, and are so disposed as to meet in the same point; that is, the point where the two side counter timbers produced would meet a vertical plane passing through the longitudinal axis. Upon the round up of the upper knuckle, which is a vertical round up, drawn through the spots before obtained at the middle line and side counter timber (27) in the body plan, space the lights so that they may be properly proportioned, as their height will be determined between the water table

upon the upper counter rail, and to the heading, which is about 1½ inch below the lower side of the deck transom. When the lights are determined, place the timbers immediately between them, and produce them up so as to tend towards the point above the stern, and down to the wing transom; though, below the lower knuckle, they will sometimes require a cast to form the gun-room port.

134. Draw across the stern in the body plan, an horizontal line, at the height of each of the level lines already run off, and that have the horizontal rounds aft obtained in the half-breadth plan (126). Take the distances of the midship side of the counter timbers from the middle line, at each level line and knuckles in the body plan, and set them off on their corresponding rounds aft, from the middle line of the half-breadth plan; then, take, in the body plan, in the direction of the midship side of each timber above the level line, at the middle of the wing transom, the height of the level lines and knuckles, and set them off above the same line in the sheer plan, and draw short horizontal lines through them; and to these level lines, square up where their stations, just got in the half-breadth plan, cut their corresponding horizontal rounds aft. These squarings up will give spots, through which curves must be drawn for the form of the several midship counter timbers; and to cut off their lower ends, take the distance, in the direction of the timber, what the upper side of the wing transom is below the level line at the middle of the transom in the body plan, and set it off below the same line in the sheer plan, and through the distances thus obtained draw lines to the sheer of the transom; these lines will be the lines to cut off the moulds. A single mould is in general made to answer for the whole, by marking the heights of the knuckles and alteration of the timbers upon it.

135. To take the bevellings, draw fore and aft lines to the stations at the horizontal rounds aft, and place the stock to these lines, and tongue to the round aft; and when applied, keep the stock to the level lines and tongue horizontal; and for the bevelling of the knuckles, and at the wing transom, place the stock to the inclination of the timber, and tongue to the round up, and when applied, keep the stock perpendicular to the level lines.

To lay off the Timbers that form the Circular Stern.

(Plate V., Fig. 10.)

136. Draw in the sheer plan the rake of the post timber, which will

be the fore side of the rabbet produced up; and in the sheer and body plans a level line, to the height nearly of the upper sill of the lower deck ports, and run it off in the half-breadth plan, of a form so as to give a suitable curve to the guns to be trained to every angle; that the two right aft guns, one right aft and quarter gun, or that the quarter and aft broadside guns may be brought to bear on the same point, as much within the range of shot as possible: this curve should be determined when constructing the draught. The body below water remains the same; draw, therefore, in the body plan, several proof timbers, the after one being as near aft as possible, from the level and diagonal lines, as got in for fairing the body, making them conform likewise to the level line just run off; above, get the timbers in, so as to follow the topside, which must be proved as to their fairness hereafter; if the topside should be formed by a back hollow, the timbers should become straighter as they approach aft, being a straight line before they come to the ports that form the lights. In the half-breadth plan, draw lines at equal distances, about two feet apart, parallel to the middle line, and where they cut the level line before run off in this plan, square them up to the corresponding level line in the sheer plan, and draw lines upwards from these squarings up, parallel to the rake, and take likewise the distance of the line from the middle line of the half-breadth plan, and set them off from the middle line of the body plan, at the height of the level line that is run off, and draw them upwards, tending to the same point, which is in general called the centre of the stern, where the after proof timber, if produced, would meet the middle line. Then, in the sheer plan, draw the heights of the upper and lower port-sills of each deck, top-breadth, and topside lines, and where they cut the lines drawn to the rake, project them upon the corresponding lines inclined in the body plan; and where they cut the post timber in the sheer plan, project to the middle line of the body plan, and through these projections draw curves, and prove the body by the buttock and diagonal lines.

137. Where the inclined lines cross the port-sill lines, top-breadth and topside, in the body plan, take their distances from the middle line, and set them off from the middle line of the half-breadth plan, and draw short lines through them, parallel to the middle line; and where the raking lines cross the port-sill lines &c. in the sheer plan, square them down to the corresponding short lines just drawn, and post timber to the middle line in the half-breadth line, and pass a curve through them: these curves will be the form of the stern at the port-sills, &c.

138. Upon the lower port-sill line of the middle, if a three-deck ship, and upper deck, if a two-deck ship, place the stations of the after broadside port, and the quarter and right aft port, so that they can be worked and trained the best. When their stations are determined, square them up to the corresponding port-sill line in the sheer plan, and from these draw lines upwards, parallel to the rake of the post timber; and likewise their distances from the middle line of the half-breadth plan, and set them off on the same port-sill line in the body plan, and draw lines upwards to the centre of the stern. We have then the projected places of the quarter and right aft ports to appear on a quarter and right aft view in a proper manner, as they form lights, and it only remains to get the disposition of the timbers in the sheer and body plans, that a good shift may be obtained, and that, unnecessarily, large and scarce timber may not be used.

(Fig. 11, Plate V.)

139. Draw, in the body and sheer plans, about three feet below the lower port-sill, a level line, L L 1, and run it off in the half-breadth plan. Upon this line, and upon the half-breadth of the deadwood, space the cant timbers, spacing them upon the level line, so as to bring two under each port, and as many as the space will allow between the ports; and as they gradually cant round from the after square frame to the port timbers, that they may not be reduced too much at the heel, two or three timbers are worked short *x*, with a three-inch abutment into the other timber. When the cants are determined, with the openings to be given in the half-breadth plan, square them to the sheer plan, for a disposition there; that is, where they cut the level lines, buttock lines, &c., in the half-breadth plan, to the corresponding buttock lines, &c. in the sheer plan, and draw a curve to them; take, likewise, the distances from the middle line, in the half-breadth plan, to where they cross the level lines and horizontal ribbands, and set them off on the level and diagonal lines, from the middle line of the body plan, and draw them in for the disposition of the timbers in this plan. Then, in the half-breadth plan, upon the middle and upper deck port-sill line, space the timbers between the ports, and square them up to the sheer plan, and draw lines to the rake, and take likewise their distances from the middle line of the half-breadth plan, and set them off from the middle line of the body plan, and draw lines up to the centre of the stern, and join, in the body plan, the disposition got from the cant and these lines, by fair curves; and to get their correct projection in the half-breadth, between the port-sill line and level line, which at present terminate the cant timbers, draw in several level lines very near

together, and run them off in the half-breadth, making them answer with the buttock lines and proof timbers. Then, take the disposition of the timbers on these lines, from the middle line of the body plan, and set them off from the middle of the half-breadth, and draw in the projection of them; if they make fair curves, square them up to the sheer plan, and complete the disposition there. The correct disposition being thus obtained in the sheer and body plans, and the projection in the half-breadth plan, it only remains to get the form for making the moulds, which may be done by the same process, both for the sterns, as formed in Figs. 10 and 11.

To obtain the Moulds for Trimming the Timbers.

140. When the disposition of the timbers is got in the sheer and body plans, the timbers are shifted, keeping them as short as possible where they require their sides to be twisted, to take the cant below and the direction of the side of the port timber above. The timbers below the shift that require their sides to be twisted, are laid off as common cant timbers (51), and those above, by taking, in the direction of the inclined lines, the distances above any level line that may fall near the butt, to the port-sill, level lines, &c., and set them off above the same level line in the sheer plan, and draw in new lines; and to these lines square up, where the timber cuts their corresponding lines, and to the intersection, draw in the form of the timber: this will give the line for the mould. The disposition of the timber is projected upon a fore and aft plane; should the timber, therefore, cant from this, the cant must be taken, to keep the mould, when applied, in a fore and aft direction; and to take the bevellings, place the stock to a fore and aft line, drawn from where the projection cuts the level lines, &c., and the tongue to the level lines, and apply them in the direction of the level lines, upon the plane of the mould.

(Fig. 11.)

141. To lay off the timbers that have their sides twisted, a mode similar to that pursued in laying off the side counter timbers (116) will be the most simple and, at the same time, correct. Draw in the half-breadth plan, a line, *a b*, fore and aft, so as to be in contact with the projection, to represent the plane of the mould; and in the sheer plan, a curve, *m o n*, at a distance from the disposition of the timber, so as to make the mould of a convenient breadth; and where the port-sill, top-breadth, and topside lines cut the disposition, draw level lines, *q o*, to the fore side, *m o n*, and square down the intersection, *q o*, to the plane of the mould, *a b*, in the half-breadth plan to the corresponding

level, port-sill lines, &c.; then, where the projection of the timber cuts each level and port-sill line, draw lines, *c e*, in the direction that the side of the timber is to stand, which, at the lower part, will be brought gradually to the cant of the lower end: from the intersection with these lines to the squarings down, *o*, of the fore side of the mould, a curve passing through the new intersection, *e*, will give the projection of the inside of the timber, if to the breadth of the mould.

142. The mould is made to the disposition of the timber, and to the fore side, *m o n*, and the lines, *q o*, marked upon it; and from the line, *a b*, representing the plane of the mould, in the half-breadth plan, spilings are taken to the projection of the outer and inner sides of the timber, at the lines squared down from the disposition and fore side of the mould in the sheer plan, and written upon the mould at their corresponding places.

143. When the mould is applied to the piece, the spilings are set off, as explained for the side counter timber (129). When the after sides are trimmed through, the mould is re-applied, and the outside projected down square to the mould. The bevellings are taken by applying the stock of the bevel to the line *a b*, representing the plane of the mould, or to lines parallel to it, and the tongue to the level lines; and when applied, the stock is kept in the direction of the crossing on the mould, and tongue perpendicular to the mould.

144. After the outside is trimmed through to the bevelling, the moulding of the timber is set off to the common scantling of the ship, and the inside trimmed after the outside.

To lay off the Timbers that come under the Wing Transom, when the Ship is not constructed with a Round Stern. (Fig. 9, Plate IV.)

145. The timbers that come under the wing transom when the other transoms are omitted, cant gradually from the timber on the end of the wing transom, which takes the place of the fashion-piece, round to the post timber, which is left as wide as possible at the head, and brought to about four inches at the heel. Lines for the plane of the side of these timbers are first got in the half-breadth plan; they are then laid off as cant timbers (51), and the bevellings taken for them, in the same manner (68).

To lay off the Hawse Pieces, when they form their Abutments against the Cant Timbers. (Fig. 12, Plate VI.)

146. When the hawse pieces are not carried down to take the common stepping of the cant timbers (30), they have the plane of their sides fore and aft, when they are called fore and aft hawse pieces; or canted, to taper their lower ends, and to bring their sides more nearly perpendicular to the body, when they are called cant hawse pieces: in both cases their disposition is the same in relation to the hawse holes, as when the timbers are gradually canted round the bow (52), as Fig. 4, Plate II.

147. Obtain, in the sheer plan, the disposition of the fore edge of the foremost cant frame, and likewise the fore edge of the first futtock before the frame, for one or more of the hawse pieces to form an abutment upon. To get the disposition, square up where the foremost bevelling edge of the foremost cant frame, in the half-breadth plan, cuts the horizontal or projection of the ribbands (55), level lines, and main and top breadths, to their corresponding sheer of the ribbands, level lines, &c., in the sheer plan, and where it cuts the half-breadth of the deadwood in the half-breadth plan, to the stepping in the sheer plan; and a curve passed through all the squarings up will give the disposition of the fore edge of the cant frame: the same must be done as high up as the sheer of the harpin, at the first head, for the disposition of the fore edge of the first futtock.

148. To lay off the fore and aft hawse pieces, will only require to obtain a projection of them in the sheer plan, as the plane of their sides is fore and aft; draw, therefore, in the half-breadth plan, their stations, by lines fore and aft. In placing them, as before described (52), and where these stations cut the level lines, horizontal ribbands, and main and top breadths, square them up to their corresponding lines in the sheer plan, and draw curves through them: it will be to these curves that the moulds are to be made.

149. The moulds are in general made to the fore side of each hawse piece, and are cut off at the lower end, by squaring up from the half-breadth plan, where the fore side cuts the fore edge of the cant timber, to the disposition of the fore edge of the cant timber in the sheer plan, and there drawing a line perpendicular to the keel. Upon the moulds are marked the heights of the harpins, top breadth and top side, port sills, and others for bevelling spots, if these places are not sufficiently

near for the bevellings; the station and direction of the harpins are got by drawing horizontal lines in the sheer plan, where the disposition of the hawse pieces cuts the sheer of the harpins.

150. The bevellings are got in the sheer plan by taking the shortest distances between the fore and after edges, which is from the fore edge of one hawse piece to the fore edge of the other, at each bevelling spot, and setting them below a square in the siding of the hawse piece, as explained for other timbers (68); and when applied, the stock is kept square to the curve. For the heel, the bevelling is taken by placing the stock of the bevel to the station of the hawse piece, or fore and aft, in the half-breadth plan; and the tongue to the cant timber, and applying it horizontal, or perpendicular to the heel up and down.

(Fig. 12, Plate VI.)

151. To lay off the cant hawse pieces upon the line at the height of the hawse holes, set off abaft the after hawse hole (52), the siding of one timber, except what it may be cut by the hole, and draw a line, *a b*, for the joint of two hawse pieces, to cant from a fore and aft line as much as possible, without reducing the lower ends too much; draw, likewise, the line *m n*, in the middle, between the two holes for the joint of the two hawse pieces that are placed between them; and, abaft the joint *a b*, draw in the joints, for as many others as will fill up the space to the fore side of the foremost cant timber, and produce them aft to cut the first horizontal ribband abaft the fore edge of the foremost cant frame. And to obtain the proper form for making the mould, the intersection of their joints with the fore edge of the foremost cant frame is made a vertical axis, upon which they revolve, which is represented by the middle line of the body plan, where they are thrown upon a vertical plane; take, therefore, perpendicular to the middle line, the distances to where the joints cut the horizontal or projection of the ribbands, and set them off square to the middle line in the body plan, so as to cut the plane of their corresponding diagonals, and draw short lines through them. Then take the distances, in the half-breadth plan, forward, in the direction of, and from where the joint cuts the foremost edge of the foremost cant timber, to the horizontal or projection of the ribbands, and set them off from the middle line, on their corresponding short lines just drawn in the body plan; take, likewise, from the half-breadth plan, the distances to where the joint cuts each level line, and set them off from the middle line, on their corresponding level lines in the body plan; and to obtain spots on the port-sill, and main and top-breadth lines, square up where the joints in the half-breadth plan cut

these lines, to their corresponding lines in the sheer plan, and transfer the heights to the body plan, and draw level lines to them; then take the distances, in the direction of the joint, from where it cuts the fore edge of the foremost cant frame to these lines, in the half-breadth plan, and set them off on their corresponding lines just drawn in the body plan: a curve passed through the spots thus obtained will give the proper form for making the mould. To regulate the form at the lower end, one spot may be obtained on the other side of the middle line, by taking, square to the middle line in the half-breadth plan, a distance to where the joint cuts the horizontal or projection of the ribband, that is abaft the fore side of the cant frame, and set it off from the middle line in the body plan, to cut the corresponding diagonal, and draw a level line through it; then take the distance, in the direction of the joint, abaft the fore edge of the cant timber, in the half-breadth plan, and set it off on the other side of the middle line in the body plan, on the level line just drawn, and produce the curve through to it; a spot likewise may be got on the middle line of the body plan. Square up where the joint cuts the fore edge of the cant, in the half-breadth plan, to the disposition of its fore edge in the sheer plan, and transfer the height to the middle line of the body plan; this height should agree to where the hawse piece crosses the middle line.

152. The mould is made to the curve thus obtained in the body plan, and cut off, for the heel up and down, to the middle line; and to cross the mould, the height of the top and main breadths, and port-sills, are marked upon it; and for the height and directions of the harpins, draw a line from where the squaring out from the diagonal, obtained from the horizontal projection of the ribbands, cuts the curve for the hawse piece, to where the diagonal cuts the middle line; this line marked upon the mould gives the station and direction of the harpins: if these lines are not sufficiently near for the bevellings, other sirmarks are marked upon the mould for them.

153. To lay off the bevelling edges, draw, in the half-breadth plan, on each side, and parallel to the joint, lines for them, at a distance equal to the siding of the hawse pieces, and from where the joint cuts the fore edge of the cant frame, draw a line, *o p*, square to the joint, to these lines; and to get the bevelling edges in the body plan, proceed in the same manner as explained for the joint, except that the distances to the horizontal or projection of the ribbands, in the direction of the lines for the bevelling edges, in the half-breadth plan, are taken from the line *op*, instead of from the fore edge of the cant timber, and set off from the middle line of the body plan.

154. The bevellings are got by taking the shortest distance between the joint and bevelling edges, as shown by dotted lines, in the body plan, and setting them off above or below a square in the siding of the timber, as before explained (150), and applied square to the curve. The bevelling against the cant timber is taken by applying the stock to the joint, and tongue to the cant timber, and applied to the piece; the stock is kept horizontal, or perpendicular to the keel up and down.

To lay off the Head. (Fig. 12, Plate VI.)

155. Upon the floor, at some convenient place, if there is not room before the stem, as already laid off (9), place the stem mould, and mark by its fore side, and fore edge of the rabbet; and from the draught transfer to the floor, in a proper position, with the stem, as just drawn, the outline of the knee, the flight of the cheeks, hair bracket, and scrolls, and upper side of the main rail; and, in the half-breadth plan, run off half-breadth lines, taken at the height of the upper side of the upper and lower cheeks, and top breadth (except the after part of the main rail should not be at the top breadth, then at the height where it comes in contact with the side); and without these half-breadth lines, draw in the thickness of the exterior planking.

156. Square down from the sheer to the half-breadth plan, the fore side of the knee TS, and fore end of the main rail, *bb*, and draw in, above the middle line of the half-breadth plan, the half-siding of the knee, by setting it off at the fore part, and as squared down at the stem, and drawing a straight line; draw in, likewise, the half-siding of the lacing of the figure. In this plan, get the proper position of the cat head, and set off at the fore side, without the exterior planking, upon the half-breadth line, run off at the height of the rail, the siding of the after part; and from this spot to where the line, squared down from the fore end of the rail, cuts the half-breadth of the lacing, draw the line *a b;* this line will show the distance that the outside of the rail is from the middle line, or plane of the outside of the rail, and will be the line round which the rail will revolve, when thrown on a horizontal plane, to get its true length and form, as the rail shown in the sheer plan is only a projection; and within this line draw another for the inside, to the siding of the rail.

157. In the sheer plan, draw, at the height of the fore end of the rail, the line $a'b'$, and at equal distances of about eighteen inches apart (except about four at the after end, which should not be above half this

distance), draw lines downward, as low as the lower rail, perpendicular to the keel, and square them down to the half-breadth plan, and where they cut *a b*, draw out lines perpendicular to it; then take the distances from $a'b'$, in the sheer plan, to the upper part of the rail, at the lines drawn down to the lower rail, and set them off from the corresponding lines just squared out from *a b*, in the half-breadth plan; square down, likewise, where the fore side at the after part of the rail cuts $a'b'$ in the sheer plan, to *a b* in the half-breadth, and draw a line towards the middle line, square to *a b;* a curve passing through the distances before set off, and ending at the after part at the line just square to *a b*, from the fore side of the cat-head, and terminating at the fore part, to where the fore end of the rail, squared down from the sheer plan, cuts the half-breadth of the lacing, will be the curve for the upper part of the rail extended in the half-breadth plan. To obtain the lower edge, that the rail may have the proper moulding and regular tapering, pen a batten round the curve for the upper part, as just drawn in the half-breadth plan, and marking on it all the lines drawn perpendicular to *a b* and the fore end; then upon a straight line, *m n*, in some convenient part of the floor, place the batten, and mark upon it the fore end, and the intermediate spots taken at the lines perpendicular to *a b*. At the fore end, and at *a b*, set off the moulding of the rail, and draw another line, $m'n'$, to give the tapering of the rail; and between these two lines take the distances at the intermediate spots, and set them off in the half-breadth plan, square to the curve drawn in for the upper side of the rail, at their corresponding lines perpendicular to *a b*, and draw in a curve to them, for the lower side, ending it at the square line for the after end perpendicular to *a b*, at a distance from the upper side equal to the moulding of the rail. When the lower side of the rail is thus obtained in the half-breadth plan, transfer it to the sheer, by squaring where the aft side cuts *a b* in the half-breadth plan, to $a'b'$ in the sheer plan, and drawing there a line perpendicular to it; take, next, the distances from *a b*, at the intermediate line or lines perpendicular to it, to the lower side of the rail, and set them off on their corresponding lines, below $a'b'$, in the sheer plan: a curve passing through these spots, and forming into the straight line drawn for the aft side, perpendicular to $a'b'$, will give the lower side of the rail in this plan, as would appear before it is champhered. To obtain the inside of the rail, as it would appear when champhered, make a mould, M, to the size of any transverse section of the rail; it may be just before the calf's tongue;*

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* This method is to be used when the main rail is of a curved form, at the after end, and runs up by the fore side of the cat head; but in form, as shown in Figure 12, Plate VI., the champher and moulding are carried quite aft to the supporter or bow.

and draw upon it the moulding that is to be struck upon the rail, and without this moulding draw a line for the champher; then take the size of the rail, from the mould, at the lower part, to the champher, and set it off from the line that represents the inside of the rail, in the half-breadth plan, at the place to which the mould corresponds in size, and draw the dotted line *o s*, so as to be from the outside of the rail as follows:—As the champher is to the size of the rail, at the part where the mould M is made, so must the champher at any other part be to the size of the rail at that place; now, where the intermediate lines squared down from the sheer plan to the half-breadth plan cut the lines, for the inside and champher of the rail, draw lines square to *a b*, to the lower side of the rail. For the champher, take the distances to the lower side, at the lines squared from the champher, and set them off from $a'b'$, on their corresponding lines in the sheer plan, and draw a curve through them; this will give the athwartship projection of the rail, as it will appear when champhered. Take likewise from *a b* in the half-breadth plan, the distances at the intermediate lines, square from the inside of the rail to the upper and lower side, and set them off from $a'b'$ in the sheer plan, on the corresponding lines, and pass curves through them; and this will give the athwartship projection of the upper and lower sides of the rail, at the inside. These athwartship projections will only be necessary to obtain the appearance of the rail, or to lay off the head timbers correctly, which is unnecessary, as here the mould is to be made to the form as obtained in the half-breadth plan.

158. To lay off the middle rails: Get in the sheer plan the middle rails, so as to have equal spaces between them, with likewise the same spaces from the lower side of the main rail to the upper side of the upper cheeks, at each head timber; the after head timber, which is called the stem timber, has in general the same rake as the stem. In the half-breadth plan get the moulding of the cheeks, *x*; and to obtain the spread of the middle rails, which must be got in to lay them off, obtain the form of the after head timber, at its aft side, upon some convenient part of the floor. At the plan of the timber, B, draw a line to represent the middle line, *a b*, and another perpendicular to it, for the upper side of the cheek, *c x*; and from the sheer plan take the height of the upper and lower sides of the main rail, and set them off above the line for the upper side of the cheek, in the plan of the timber, and draw through them lines perpendicular to the middle line; then, where the head timber in the sheer plan cuts the under side of the rail, square it down to the inside and outside of the rail in the half-breadth plan, and where it cuts the upper side of the cheek in the sheer plan, to the

outside of the cheek, *x*, in the half-breadth plan; and from these squarings down take the distances from the middle line to the outside and inside of the rail, and to the outside of the cheek, and set them off from the middle line on their corresponding lines in the plan of the timber, and to the heights and breadths, for the rail, draw in a section as before shown, M; then, from the lower part of the rail, at the outside, and to the breadth for the outer part of the cheek, draw in the curve of the timber. To cut the curve for the timber, draw in lines for the heights of the upper and lower sides of the middle rails, taken above the cheek at the aft side of the timber; and at these heights draw in the sections of the rails, *y* and *z*, with their outsides coinciding with the curve; then, from the sheer plan square down the fore ends of the middle rails to the lacing in the half-breadth plan, and from the plan of the timber take the distances that the outside of the sections of the middle rails are from the middle line, and set them off on the aft side of the timber, in the half-breadth plan, squared down before from the sheer plan, at the upper part of each rail; and at these distances out and to where the squarings down of the fore end cut the lacing, draw straight lines, *o p* and *c d*, which will represent the plane of the outside of the rails, and be the lines round which the rails will revolve when they extend upon an horizontal plane.

159. To expand the middle rails, draw, in the sheer plan, at the height of their fore ends, the horizontal lines *o′p′*, and in the half-breadth plan draw lines square to *o p* and *c d*, where the lines before squared down for expanding the main rails (157) cut them, and proceed in the same manner to obtain the form and get the tapering of these rails as for the main rails.

To make the Moulds.

160. The moulds for the rails are made to the expanded curves, as obtained in the half-breadth plan; they are formed both to the upper and lower sides of the rail, so as to give the moulding or breadth of the rails up and down; and the moulds for the cheeks are made the moulding way to the lines, as got in the half-breadth plan, *x*, and for the flight, as got in the sheer plan, *y y y*. (Note 15.)

161. The mould for the knee of the head is a batten mould; one batten is placed with its after edge to the fore side of the stem, and extends from within about three inches to the under side of the bowsprit, down to the scarph of the gripe, and one to the fore side of the knee, which extends from the seat of the figure to the scarph of

the gripe; but as the knee at the scraph of the gripe is narrow, the mould is in general made in one, to form the scarph, and the two battens that form the fore and after parts scarph into it. The upper part is made to the cutting down of the knee, *oo*, which is set off above the upper cheek, and to be abaft the hair bracket, to form a stop for the rails; it is made likewise to give the lacing and seating of the figure. The mould is supported by cross battens, which are in breadth the half-siding of the knee. To get the breadths of the battens, *e*, mark first upon the mould their positions, and determine, at the lower end of the knee, or, if the gripe mould is to be made at the same time, at the lower part of the gripe, the taperings from the rabbet of the stem; then, pen a batten round the fore part of the knee, and gripe if the mould is to be made, and mark upon it the upper and lower parts, and stations of the battens. Then, just before the knee, or on some convenient part of the floor, let the batten fly straight, or place it against some straight line, and mark the upper and lower parts, and stations of the battens; and at the upper and lower parts set off the half size of the knee; the upper part is taken from the half siding at the fore part of the knee, as got in the half-breadth plan, and the lower part from the tapering obtained at the lower part of the knee or gripe, as just got in the sheer plan; and strike the lines S T, the distances between which will give the half-siding of the fore part of the knee, at any of the intermediate parts or stations of the battens, and the half-breadth of these battens at the fore part. To obtain the half-breadth at the after part, take the heights in the sheer plan where the stations of the battens cut the fore edge of the rabbet, and transfer them to the stem (13) in the body plan, and at these heights take the half-siding of the stem for the breadth of the battens at the rabbet; then, from this breadth to the one obtained at the fore part of the knee, draw a straight line, which will give the breadth of the cross battens and the half-siding of the knee; but that the knee under the cheeks may have the greater substance, or the surface under them be in the same plane, square down where the stations of the battens cut the lower side of the lower cheek, and cutting down to the half-breadth plan, and the half-siding of the knee, before got in (156), at the squarings down, will give the breadth of the battens, or the half-siding of the knee in the wake of the cheeks.

To lay off the Stern. (Fig. 13, Plate VII.)

162. Upon some convenient part of the floor, strike a line, S T, to represent a level line at the height of the wing transom, at the side, and draw a line perpendicular to it for the middle line of the stern;

then transfer from the sheer plan the side and midship counter timbers (26) to the proper rake and height above the said level line, at the wing transom at the side, and so disposed as just to be clear of the stern: this may be called the plan of the quarters. And from the body plan transfer the side counter timber on each side of the middle line, with the knuckles of the upper and lower counters, agreeing in height to the knuckle of the timber in the plan of the quarter: this may be called the plan of the stern.

163. Project from the midship timber in the plan of the quarters, the height of the upper and lower knuckles to the middle line in the plan of the stern, and through them, and to the knuckles at the side timbers, draw in the round-up of the lower and upper knuckles. At the upper knuckle, in the plan of the quarter, draw a short line that shall form an angle common to the upper counter and upper part of the timber, or being between two squares to these parts of the timbers; and one likewise at the lower knuckle, forming the same to the upper and lower counters, and set off upon the upper one the thickness of the plank of the upper counter, and upon the lower one the thickness of the plank of the lower counter; next, at these thicknesses out, draw lines to the sheer of the ship, and above them, others parallel, at a distance equal to the depth of the rails; and between these lines describe the sections of the upper counter rails A, and lower counter rails B, at their proper knuckles, forming at the lower part a small hollow within a quarter of an inch of the thickness of the plank of their respective counters; and upon the upper counter rail draw in a section of the water table. Then project the upper part of the water tables, at the outside of the munions, and the upper and lower sides of the rails, to the middle line of the plan of the stern, and to these projections draw curves parallel to the round-up of the knuckles. These curves should be constructed as before described, as they are only arcs of circles square to the sheer (71).

164. In the sheer plan of the stern get in the inside of the side counter timbers, according to the common scantling of the frame; and in the plan of the quarters get in the deck at the side, with the proper sheer, to extend forward to the stations of three or four square timbers; and where it cuts the side timber, project to the side timbers in the plan of the stern, and take the distance of this projection, in the direction of the side timbers, and set it up the middle line; a curve drawn through this spot and the height on the side timbers, will give the round-up of the deck at the stern, and upper side of the beam; this may be transfered to the midship timber in the plan of the quarter, and a line drawn through it to the sheer of the deck at the middle,

which is made to conform to the common round-up of the beams, at about the third beam. In the plan of the stern, below the upper side of the beam, draw in a line for the depth of the transom; and below that another, about 1½ inches, for a moulding, which will give the heading of the lights. Upon the water table space the munions, bringing the midship side of the one that is on the side counter timber, so as to cover the interior planking; and beyond this one, space one light and a munion, and beyond this munion, a distance equal to the breadth of a munion, or what may be necessary if it is to be carved, for the outside of the quarter;* then draw lines from the water table up to the heading, tending to the centre of the stem; these lines will show the lights.

165. In the half-breadth plan run off half-breadth lines taken at the height of the upper and lower counters, and at the height of the deck at the side, and without them draw in the exterior planking; and from the plan of the quarters square down the midship and side timbers, at the height of the knuckle of the upper and lower counters, and deck, to their corresponding lines just run off, and to the middle line, in the half-breadth plan, and draw in the projected rounds aft; then, where the aft side of the munions cuts the upper side of the water table, on the section of the upper counter rail, at the midship timbers, in the plan of the quarters, square it down to the middle line of the half-breadth plan, and from this squaring down draw a line parallel to the projected round aft; this will give the outside of the munions in the half-breadth plan. Then, where the height of the water table, at the outside of the munions, cuts the line just drawn for the outside of the quarters, in the plan of the stern, project it to the plan of the quarters, and draw a short level line; then take the breadth, from the middle line, at this height, to the outside of the quarters, in the plan of the stern, and set it off from the middle line, on the line for the outside of the munions, in the half-breadth plan, and draw a line fore and aft; and where this fore and aft line cuts the outside of the munion, square it up to the short level line, just drawn, in the plan of the quarters, and the intersection will give a point, for the outside of the munions, at the height of the water table, in the plan of the quarters; and from this point draw forward a line parallel to the sheer, and upon it space the lights and munions, for the quarter. At the spacing of the fore side of the foremost munion, square down a spot to the half-breadth line, to

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* The part beyond the munion on the side counter timber may be entirely according to taste; but there is commonly the space of one mock light shown, to give the quarter gallery a proper breadth.

the line run off at the height of the upper counter, in the half-breadth plan, and from this squaring down to the fore and aft line before drawn to the breadth of the outside of the munions, describe, in order that the sash may slide, an arc of a circle, to a large radius, letting the fore and aft lines be a tangent to it; this arc will give the outside of the munions of the quarter, in the half-breadth plan.

166. In the plan of the stern, produce the round up of the upper side of the beam to the line for the outside of the quarters, and project the height of the intersection to the plan of the quarter; then, where the sheer of the under side of the deck at the middle cuts the outside of the munion, at the middle timber, in the plan of the quarters, square it down to the middle line of the half-breadth plan; and from this squaring down draw a round aft parallel to the projected round aft before drawn in to the half-breadth plan at the height of the deck. When this is done, take the breadth, at the line produced for the upper side of the beam, to the outside of the quarter, and set it off from the middle line on the corresponding line, for the aft side of the munions, in the half-breadth plan; and where it cuts it, square up a spot to the projection of its height, in the plan of the quarters, and from this squaring up to the point for the outside of the munion before obtained (165) at the water table, draw a line, which will give the rake of the quarters.

167. Produce in the plan of the stern the heading of the lights, to cut the outside of the quarter, and project the intersection to the line just got in for the rake of the quarter, on the plan of the quarter, and to it draw a line forward to the sheer; this line will give the heading of the lights in the quarter. Then, from the line at the height of the water table, at the outside of the munions, to this line, draw in, parallel to the rake of the quarter, to the spacings before obtained, lines for the munions and lights, *c c c;* these will give the form of the lights in the quarter, *d d d.*

168. Square down from the midship timber, in the plan of the quarters, the after part of the section of the upper counter rail, to the middle line of the half-breadth plan, and from it draw a curve parallel to the projected round aft; this will give the aft side of the rail. At the same distance that this line is abaft the line for the aft side of the munion, draw a line without the curve, for the outside of the munion of the quarter, in the half-breadth plan; this will give the outside of the rim rail. Then, where the outside of the rim rail cuts the aft side of the rail in the half-breadth plan, square it up to the plan of the quarter; and from the half-breadth plan take the breadth, from the middle line, to where the outside of the rim rail cuts the aft side of the rail, set it off

from the middle line in the plan of the stern, and project it to the end of the rail just squared up in the plan of the quarter. We thus have the end of the upper counter rail in the three plans, and the projection of the rail, in the plan of the quarters. Between the section, on the middle timber, and this point, the projection of the rails may be got, by drawing any number of short lines parallel to the middle line, to cut the rail in the half-breadth plan, and others at the same distances from the middle line of the stern, to cut the rail in the plan of the stern; then, if they are squared up, from the half-breadth plan, where they cut the aft side of the rail, or lines for the munions, or any other lines to the plan of the quarters, and the height of the same lines at their corresponding short lines, projected from the plan of the stern; to cut these squarings up, curves being passed through the intersections thus obtained, we have the projection of the rail in the plan of the quarter. The same progressive method may be gone through for the lower part of the rail and outside of the berthing of the upper counter rail, at the lower part. From the points just got for the extremities of the rails, at the side, in the plan of the quarters, draw lines to the sheer for the upper and lower sides of the rim rail, and outside of the berthing; and for their ending forward, square up the point where their corresponding lines, in the half-breadth plan, for the fore end of the rail, &c., cuts the exterior planking, to the plan of the quarters.

169. For the lower counter rail, proceed in the same manner to obtain the aft side of the rail, and aft side of the berthing of the upper counter, as described for the upper counter rail; then, from the outside of the berthing, in the plan of the stern, at the extremity of the quarter, from the under side of the upper counter rail, draw a line tending to the outside of the exterior planking, at the extremity of the wing transom; and where it cuts the upper side of the lower counter rail, project its height to the plan of the quarter. Then, from the plan of the stern, take the breadth from the middle line to the outside of the berthing, at the upper side of the lower counter rail, and set it off from the middle line on the aft side of the berthing, at the lower counter rail in the half-breadth plan, and square it up to the plan of the quarter, on its corresponding height just projected; and from this point to the point under the upper counter rail, for the aft side of the berthing, draw in the curve of the upper counter; and from the point just squared up, draw forward a line to the sheer, for the upper side of the lower stool rail at the berthing.

170. From the middle of the centre light of the quarter, draw a line to the rake, and produce it down, to form the lower finishing; and

draw in the depth of the stool rail. Below this rail form the lower finishing, observing to make the centre of the drop, *o*, that is below the finishing, on the line just drawn through the centre of the middle light; and making a line, drawn from the fore end of the berthing, under the rim rail, form a tangent to the fore part of the finishing; then, where this line cuts the upper part of the stool rail, square it down to the outside of the exterior planking, that is, without the half-breadth line run off at the height of the lower counter rail (165), in the half-breadth plan; and from this squaring down to the breadth set off on the aft side of the berthing (169), draw in a curve which maybe similar to the curve of the rim rail; and outside this curve draw another for the outside of the rail, at the same distance as the after part of the rail is from the line for the berthing; then, where this line cuts the outside of the exterior planking, square it up to the plan of the quarters, for the end of the stool; and where it cuts the after edge of the rail, take the breadth from the middle line, and set it off on the upper part of the lower counter rail, from the middle line in the plan of the stern, for the end of the lower counter rail; then project, on the spot just squared up to the plan of the quarters. From this point, for the end of the rail at the extremity, both in the plan of the stern and quarters, to the section of the rail on the middle timber in the plan of the quarters, the form of the rail may be obtained, as explained for the upper counter rail (168).

171. When the stern is constructed to be all the way up in the same cylindrical surface, whether a two or three deck ship, it will only require to get the heights of the different decks, and the lower sides of the transoms, to obtain the heading of the lights, as before explained, and to give the rails the increased round, according to the inclination of the side counter timbers; and making the munions on both sides tend to the same point, the centre of the stern, will give them the proper taper. But when the stern is constructed with a balcony, which mode of construction is now frequently continued, it will require a different process.

172. From the plan of the quarters, square down the point where the upper side of the deck, at the middle line, cuts the middle timber to the middle line, and where the deck, at the side, cuts the side timber, to the half-breadth line, at the height of the deck in the half-breadth plan; and to these squarings down, draw the round aft to conform to the round of the stern below, and produce it beyond the half-breadth line, the width of the stool. Parallel to this line, from the half-breadth line, out to the width of the stool, draw another abaft, about eight

inches, to give room in the balcony; and from this curve to the middle line, draw an inflected curve to the form, and to the distance the balcony is to be aft, for cutting off the ends of the deck, and for the fore side of the foot space rail, *k m n*.

173. Draw, perpendicular to the middle line of the half-breadth plan, a line Y Z, at a convenient distance abaft the curve just got in for the fore side of the foot space rail, and from it draw in the vertical round-up of the deck, Z *z*. From this round down draw several lines, parallel to the middle line, as numbered 1, 2, 3, 4, &c., to the fore side of the foot space rail; and where they cut it, square them up to the upper side of the deck, at the middle line in the plan of the quarters; then, from the line Y Z, take the distances to the round down Z *z*, at each of these lines, and set them off below the upper side of the deck, at their corresponding lines in the plan of the quarters, and draw a curve through them, which will give the projection of the upper and fore sides of the foot space rail at the ends of the deck, in the plan of the quarters. From the plan of the stern, take the breadth from the middle line to the outside of the munion of the quarter, at the height of the upper side of the deck, and set it off from the middle line on the round aft of the deck, produced for the width of the stool (172), in the half-breadth plan; and describe an arc of a circle parallel to the outside of the munions, as before drawn on the rim-rail (165), for the outside of the middle stool, and produce it aft to the fore side of the foot space rail.

174. In the plan of the quarters, at the middle, conforming to the projection of the fore and upper sides just got in, draw a section of the foot space rail, and square down its aft side to the middle line in the half-breadth plan; and to this squaring down, draw a curve parallel to the one for cutting off the end of the deck, for the aft side of the rail, and one at the same distance, outside of the stool, for the outside of the middle stood rail; then, where the lines numbered 1, 2, 3, 4, &c., cut the aft side of the rail, square them up to the plan of the quarter, and take the distances from Y Z, at each of these lines, to the round-down, and set them off at their corresponding lines just squared up, below a line drawn parallel to the sheer of the deck at the middle, drawn in the upper and aft sides of the rail; and where the outside of the stool rail cuts the aft side of the foot space rail, in the half-breadth plan, square it up to the plan of the quarters, and project it likewise to the line Y Z, as 11, and there take the round-down, which round-down set below the sheer line drawn from the upper and aft sides

of the rail: a curve passed through the spots thus obtained will give the projection of the aft and upper sides of the rail. The same may be done for the lower side of the rail.

175. Take from the half-breadth plan, the distance that the end of the foot space rail, at the fore and after sides of the lines numbered 1, 2, 3, 4, &c., are from the middle line, and draw lines to these distances from the middle line in the plan of the stern; and from the plan of the quarters project the fore and after parts, and lower side of the rail, at their corresponding places, squared up from the half-breadth plan to them; and draw in the projection of the upper and lower parts, for the aft side and upper part, and draw in the quarters, from the points squared up for the extremity of the rail, the upper and lower sides of the stool rail, ending it by squaring up its fore end from the half-breadth plan.

176. Draw in the plan of the stern the outline of the taffrail and quarter pieces. It may be to an inflected curve, as shown in the figure, or any other curve that may be according to the taste of the projector, confining its boundary so as to be at the proper height of the taffrail, to cover the planksheers at the top side, and so as, at the outside of the quarter piece, to form into a line drawn from the extreme end of the foot space rail, for ships that have a balcony, and for those without, to the end of the upper counter rail, where there is no balcony.

177. The cove and inside of the quarter pieces must likewise be drawn; the cove, in a solid taffrail and open balcony, has the necking as much below the transom of the round-house, as the heading of the lights is below the lower side of the other transoms; though sometimes it has a quicker round, when it is kept below the transom at the middle, and carried down at the side.

178. The sterns, at present, instead of having a solid taffrail, have the stern timbers to run all the way up, and a rabbetted backing of about two inches in thickness brought on their aft side, from the heading of the lights up to the height where the fife rail was formerly placed, and the mouldings to form the outline, and the cove, are brought on. The quarter piece is still solid from the outside of the exterior planking, without the side counter timber; though it sometimes rabbets to the timber, to about half its substance, and the backing butts against it.

179. When the taffrail quarter pieces and cove are formed in the plan of the stern, obtain their projection in the plan of the quarter. Draw, in some convenient place, either above or below the stern, from a straight line M O, that is perpendicular to the middle line of the stern, an arc of a circle, *m o*, for the round aft square to the rake, with its vertex immediately above or below the middle line of the stern. Upon the outline of the taffrail and quarter piece, in the plan of the stern, draw in any number of short lines or distances, and project them to the straight line M O, and to the arc *m o*, and to the middle timber in the plan of the quarters, where short lines may be drawn. Draw in the plan of the quarters, parallel to the middle timbers, a line *s u*, abaft it; if a solid taffrail and open balcony, eight inches, or the thickness of the taffrail; but if the timbers run up the thickness of the backing, then take the distances from the line M O, to the arc *m o*, at each of the distances projected from the outline, and set them off, perpendicular, and before *s u* in the plan of the quarters, upon the corresponding short lines, just projected from the outline of the taffrail to this plan, and draw a curve through them; do the same for the lower end of the quarter piece: a curve passing through the spots thus obtained will give the projection of the aft side of the taffrail and quarter piece, at the after surface of the taffrail in the plan of the stern, abaft which may be drawn, if the taffrail is not solid, the thickness of the mouldings, which below the side timber gives the aft side of the quarter piece, as they are worked out of the solid; and before this line the siding of the quarter piece may be set forward for its fore side; but when it is a solid taffrail, its siding is set before the projection of the surface of the taffrail, for its fore side. The projection of the cove and inside of the quarter piece may be obtained in this plan by the same progressive method as gone through for the taffrail and outside of the quarter piece.

180. The upper quarter can now be got in by observing the same method as for the lower, in forming the rails that correspond with the breast rails of the stem, and the stool rails; for which purpose, lines may be run off in the half-breadth plan, and the form of the rails got in this plan, as before explained.

181. To lay off the breast rail, from where the numbered lines 1, 2, 3, 4, &c., in the plan of the stern, cut the fore and upper sides of the foot space rail, draw lines, tending to the centre of the stern, as *x y*, and in the plan of the quarter, as *o p*, to the rake of the midship timber; then, in the plan of the stern, set up the height of the fore and upper sides of the breast rail, in the direction of the lines inclined

to the centre of the stern, and project them to the lines just drawn in the plan of the quarters; and draw in these plans the curves for the projection of the fore and upper sides of the breast rail.

182. To get the form of the breast rail in the half-breadth plan, take from the middle line the distances where the lines just drawn towards the centre of the stern cut the curve for the fore and upper sides of the breast rail, and set them off from the middle line of the half-breadth plan, drawing to them short lines parallel to the middle line, and project them up where the corresponding lines, drawn to the rake, cut the fore and upper sides of the foot space rail in the plan of the quarters; and through the squarings down pass a curve, which will give the breast rail in this plan, so that the balustrades may all be of the same length, and in the same plan, in an athwartship projection.

183. To get the aft side of the rail in the plan of the quarters, draw a section at the middle, to its proper height and position; and where the lines drawn to the rake cut the fore and upper edges, draw short lines to the sheer. Project the aft side of the section to the middle line in the half-breadth plan, and from it draw a curve parallel to the fore side, for the aft side of the rail in this plan; then square up where it intersects the short lines, before drawn parallel to the middle line, to the corresponding short lines just drawn to the sheer, in the plan of the quarters; and to the spots thus squared up draw a curve for the aft side in this plan; and from where the short sheer lines cut this curve, or from the spots just squared up, project its heights to the corresponding lines drawn to the centre of the stern in the plan of the stern, and to them draw the curve for the upper and aft sides of the breast rail in this plan. The lower side of this rail may be obtained by squaring down from the plan of the quarters the fore and after parts of the section of the lower side of the rail to the middle line of the half-breadth plan, and to these squarings down drawing curves parallel to the upper side of the rail, and then proceeding in the same manner as for the upper side.

184. The breast rail ends against the fore side of the quarter-piece, both in the plan of the stern and quarters, though sometimes it passes through the quarter-piece, and mitres into the corresponding rail on the quarters, which improves the appearance of the stern.

To expand and bring upon a Vertical Plane, the Taffrail and Quarter-Pieces. (Fig. 13, Plate VII.)

185. The taffrail and quarter-pieces, as seen in the figure, are only projections; they will, therefore, require to be expanded from the *round surface,* and to be thrown on a vertical plane, *from the rake,* to obtain the true surface for making the moulds. In the plan of the stern draw a level line, G K, to the upper part of the foot space rail, at the outside of the quarter-piece; and, perpendicular to it, or parallel to the middle line, other lines, 1, 2, 3, 4, sufficiently near to give the form correctly; and square them and the outside of the quarter-piece to the round aft, *m o,* that was before described square to the rake; and take their distances, round the curve, from the line marked upon the round aft for the middle of the stern, and set them off from the middle line, in the plan of the stern, on the line G K; and to them draw new lines, for the extended lines, as shown in the stern on a vertical plane, by the lines 1, 2, 3, 4, by the *round surface* being expanded on a plane. To obtain the stern on a vertical plane, *from the rake,* draw, in some convenient place, a line, *n t,* to the rake, in relation to some horizontal line, O V; and from the line, M O, take the distances to the round aft, *m o,* at the places where the lines drawn parallel to the middle line, in the plan of the stern, and the outside of the quarter-pieces, before squared to the round aft, and set off from the rake of the timber, *n t,* and draw lines parallel to it; then, from the plan of the stern, take the height, at each of the lines drawn parallel to the middle line, above G K, to the taffrail, quarter-pieces, cove, &c., and set them off from, and perpendicular to O V, on their corresponding lines that are drawn to the rake of the timber; and from where the line for the outside of the quarter-piece cuts O V, draw a line, *t x,* perpendicular to the rake of the timber, *n t.* Then, from this line, in the direction of the rake, take the distances to the spots, just set off above O V, on the raking lines, and set them off above G K, in the plan of the stern, on the extended lines: a curve passing through the spots thus obtained will give the taffrail, quarter-pieces, &c., expanded and thrown in a vertical plane.

To make the Moulds for the Stern.

186. To make the moulds for the counter rails, the rounds up are taken square to the sheer (Plate 7), and are arcs of circles formed

according to the common rule (Note 16), and the round afts are constructed. Draw in the sheer plan (Fig. 15) a line, *a b*, to the sheer of the ship, to pass through either knuckle,—that is, the knuckles of the upper or lower counter; the distance between these lines, taken perpendicular to them, *c d*, will be the round up. Draw a line from the upper knuckle of the midship timber downwards, square to the sheer; then strike, upon some convenient part of the floor, two lines at the distance as obtained for the round-up square to the sheer, *c a*, and mark a line perpendicular to them to represent the middle line, which will be the vertex of the arc; set off on each side of it the half-breadth of the knuckles, *m o*, taken from the body plan, and describe the round up. In the sheer plan, draw a line perpendicular to the midship timber to cut the knuckle of the side counter timber, *n q*, and produce the midship timber to it; then, from and perpendicular to this line produced, take the distance to the knuckle of the side timber, and strike two lines apart equal to it; marking upon them the middle line, half-breadth of the knuckles, *m o*, from the body plan, on each side, and describe as before an arc which will be the round aft, square to the rake; but as the round aft mould must be made upon the round down and sheer, to be conveniently applied, as the rail is formed to its round up first, draw across the round up and round aft, parallel to the middle lines, any number of short lines, at the same distances from the middle line in both; then from the round aft take the distances at each of these short lines, from the line to the arc, and set them off on the line, *n q*, drawn from the knuckle of the side timber, square to the midship timber, and to them draw lines upwards, parallel to the rake; from the round up take the distances as for the round aft at the short lines, and set them off on the line, *c d*, drawn from the upper knuckle of the midship timber, square to the sheer, and to them draw lines parallel to the sheer. To get the proper round aft, pen a batten upon the arc, for the round up square to the sheer, and mark upon it the middle and short lines; then, upon the line from which the round aft is described bring it straight, with the spot for the middle well with the middle line, and mark the spots that corresponded with the short lines when the batten is penned round the arc, for new and extended short lines; then, from the sheer plan take the distances from the line, *c d*, drawn from the upper knuckles, perpendicular to the sheer, on each sheer line, to where the corresponding lines drawn to the rake cut them, and set them from the straight line from which the curve springs, on the extended short lines just drawn across the round aft: a curve drawn through the distances thus obtained will give the round aft upon the sheer and round down, and it will be the curve to which the round aft mould is to be made. A mould for the section of the rail is likewise made at the middle timber, which gives the bevelling of the whole length of the rail, if applied fore and aft, and vertically. (Note 17.)

187. Batten moulds are made to the quarter-piece, taffrail, and cove, as expanded and thrown on a vertical plane. (185.) The quarter-pieces are trimmed to the sheer, in a fore and aft direction at the upper part, and fore and aft below; and the taffrail and cove have their upper parts and all the mouldings connected with them after the sheer. Moulds are made likewise in the half-breadth plan for the rim rails; to the foot space and breast rails, after they are expanded to the round and sheer, and for the stools. In the sheer plan for the finishings, the upper finishing has, in general, a mould made for a section of it, which is got in the plan of the stern.

To lay off a Timber when it is oblique both to the Sheer and Horizontal Plans. (Fig. 16, Plate VIII.)

188. In the sheer plan draw a line, A B, for its obliquity to the horizontal plane, and where it cuts the upper edge of the keel, square it down to the middle line of the half-breadth, and from thence draw a line, A F, for the obliquity to the vertical or longitudinal plane. In the sheer and body plans strike in any number of level lines, at the same height in both, and run them off in the half-breadth plan; and where the level lines in the sheer plan cross the line A B, square them down to the middle line of the half-breadth plan; and, from the squarings down, draw lines, af, parallel to A F, to cut their corresponding level lines, and square up the intersections to the sheer plan: a curve, $f'f'f'$, drawn through these squarings up will give the projection or disposition of the timber, or where its plane cuts the side; and to end it, on the upper edge of the keel, draw in the half-breadth plan the half-breadth of the keel, and where it cuts the line A F, square it up to the upper edge of the keel in the sheer plan; this will give the ending.

189. To get the form of the timber in the body plan, draw a line, A C, perpendicular to A B, from where it cuts the upper edge of the keel; this will be the point of revolution in transforming this timber from its projection to a vertical position in the body plan. Upon and in the direction of A B, in the sheer plan, take the distances to all the level lines, above the upper edge of the keel, and set them up, on the middle line, as n, n, n, and from the line A C, take the perpendicular

distances to where the plane, or curve of the timber, *f′ f′ f′*, cuts the level lines at the side, in the sheer plan, and set them above the upper edge of the keel in the body plan, and draw short level lines, *m, m, m,* to them; then, in the half-breadth plan, take the distances in the direction and to where the lines *a f* cut the level lines, and upon the heights, corresponding to them in the body plan, set off these distances, that is, by placing one spot on the batten, denoting the middle line of the half-breadth plan, well to the corresponding heights, *n*, on the middle line of the body plan; the other spot on the batten being made to cut the corresponding short level lines, *m*, just drawn; these intersections with the short level lines will give the spots, *m*, for the curve of the timber to pass through; and by drawing lines *m n*, will give the direction that the level lines will be thrown when the timber is transformed on a vertical plane.

190. To end this timber in the body plan, draw, in the half-breadth plan, a line within the half-breadth of the keel, for the inside of the rabbet; and in the sheer plan, below the upper edge of the keel, the distance down for the middle of the rabbet. Now where the line A B, produced down, cuts the middle line of the rabbet in the sheer plan, project it to the middle line of the half-breadth plan, and from the spot *x*, thus projected, draw a line out, parallel to A F; then, where this line cuts the line for the depth of the rabbet, project it to the middle of the rabbet in the sheer plan, and produce the curve, from where the plane of the timber cuts the side, to it. If it should pass nearer to A B than the spot before got on for the upper edge of the keel, it will end in the middle; but if it should pass without, the curve is to remain, and an angle will be formed to the middle of the rabbet. To end them in the body plan, take the shortest distances from A C, to where the plane of the timber cuts the upper edge of the keel and middle of the rabbet, and set them off from the upper edge of the keel in the body plan, and draw short level lines; and take, likewise, in the direction of A B, the distance that the middle of the rabbet is below the upper edge of the keel, and set it off on the middle line, below the upper edge of the keel, in the body plan; then take the distances from the middle line, in the direction of A F, to the half-siding of the keel and inside of the rabbet, and set them off by keeping the spots for the middle line to those that correspond at the middle line of the body plan, one of which will be at the upper edge of the keel, and the other spots being kept to their corresponding short level lines; then the curve must be passed to end either at the outside or middle of the rabbet, according as it passes within or without the upper spot.

191. To correct this timber by the diagonals, draw in the body plan, at any distance from and parallel to the middle line, a line G K; and in the half-breadth plan a line, *g k*, at an equal distance, and parallel to the middle line; then, where the diagonals cross the line G K, in the body plan, project them to the line A B, in the sheer plan, and to them draw short level lines, *d e*. Square down their intersections with A B, to the middle line of the half-breadth plan, and from them draw lines, *b c*, parallel to A F, to cut the line *g k*; project, likewise, where the diagonals cut the middle line of the body plan, to the line A B at *x*, and square them down to the half-breadth plan, to *o*; then square up from this plan, where the lines *a c*, cut the line *g k* to the short lines *d e*, in the sheer plan; and from these squarings up to the points *x*, or the heights where the diagonals cut the middle line, draw a straight line *x s*, and produce them to the projection of the harpins in *s*, which should likewise cut the intersection of the projection of the timber with this line; this will give projections where the planes of the diagonals cut the plane of the timber. Take from the sheer plan the distances from the upper edge of the keel, in the direction of A B, and set them above the upper edge of the keel, on the middle line in the body plan, for the points x'; and from A C take the perpendicular distances to where the projection of the timber in the sheer plan, or the line for the projection of the plane of the diagonal on the plane of the timber, cuts the projection of the respective harpins, and set them above the upper edge of the keel in the body plan, and draw short level lines. Then, where the projection of the harpins, *s*, crosses the projection of the timber in the sheer plan, square it down to the diagonals in the half-breadth plan, and take the distances from the middle line, at the point *o*, to the diagonals at these squarings down, and set them off from the middle line of the body plan, keeping the marks on the batten, for the middle line, to the middle at the points x', and those for the diagonals, to cut the short level lines; these intersections should be well to the curve for the timber already got in.

192. To correct the timber by the buttock lines, or the vertical longitudinal sections, take the distance from the middle line, in the half-breadth plan, in the direction of A F to the buttock lines, and set them off from the middle line in the body, and draw new and extended buttock lines; and from the sheer plan take the perpendicular distances from the line A C, to where the buttock lines cut the projection of the timber, and set them off on their new and corresponding buttock lines just got in the body plan; these distances should agree to the curve already transformed on a vertical plane.

To get the Bevelling Edge of the Timber in the Sheer and Half-breadth Plans. (Fig. 16, B.)

193. Before the bevelling edge can be got, a section, common to the two inclinations, must be obtained. Let A B be the inclination of the timber in the sheer plan, and A F in the half-breadth; draw the vertical line B F E, to cut A B in B, and A F in F, and draw from the point E, the lines E m and E n, E m perpendicular to A B, and E n perpendicular to A F; take the distances E n and E m, and set them off from E on the line E A, and draw the lines n' F and m' B; these will be sections common to the two inclinations. Now draw the line $o\,x$, equal to the siding of the timber, perpendicular to n' F, and take the distance $x\,n'$, and set it off perpendicular to A B, to cut the line E A in c; draw, likewise, the line $a\,z$, equal to the siding of the timber, perpendicular to m' B, and take the distance $z\,m'$, and set it off perpendicular to A F, to cut the line E A in c; then, from C draw lines parallel to A B and A F, which will give the fore edge of the timber in the two plans.

194. When the lines, where the plane of the side for the bevelling edge of the timber cuts the horizontal and vertical planes, are obtained, proceed to lay it off as explained for the other side; except, all distances as to height are taken from the line A C; and for breadth, instead of taking them from the middle line from lines drawn perpendicular to the cant in the half-breadth plan, A z, from where the lines for the moulding edge cut the middle line, to their corresponding lines for the bevelling edge.

To obtain the Form of the different Timbers at the Ship which are not commonly laid off on the Mould-loft Floor.

195. The examples given in the preceding pages are sufficient for all that is required, or that can be done conveniently on the mould-loft floor. At the same time, to lay off every timber that enters into the frame of a ship is possible, and the mould can be made and bevellings taken with the greatest exactness; but as it regards the after part of the ship, with those timbers that form the stern, trouble would be saved, and, commonly, more certainty attained, by mocking out the sides of each timber, and making the mould at the ship. The cant timbers are laid off on the floor, as far aft as the frames preserve a straight side, and extend all the way up. The midship counter-timber is likewise

laid off, and bolted to the side of the post, extending up to the top-side; but for the intermediate stern timbers, moulds are commonly made at the ship.

196. To obtain the form of those timbers that are not laid off on the mould-loft floor, the whole of the harpins are trimmed and fixed in their places as usual, as high up as their after ends connect with the stern-post; and, above the continuation of the ribbands on the side, are trimmed to the form, and made to extend sufficiently aft to secure the right aft ribbands to them, observing to have one at the height of each knuckle.

197. To give the form of the right aft of the stern, ribbands are fixed at each of the knuckles, and as many above as may be required. Those fixed to the knuckles are trimmed to the round-aft and round-up. (186.) Those above, to the round-aft only, and commonly laid square to the rake of the stern, and are placed to the same heights as the ribbands on the side, that they may be fixed to them. When the whole of the ribbands and harpins are got up, and properly fastened and shored, the stations of the right aft timbers are got on the ribbands for the upper part of the stern; and those at the height of the knuckles to conform to the lights and ports, as they may be disposed for properly fighting the guns, or for the proper appearance of the stern. When these stations are set off, battens are nailed on each of these ribbands, to give the direction in which the sides of the timber should stand; up and down battens are likewise got in to them, and carried down inside to the lower harpins, so as to conform with the first, double, or second futtock below, agreeably to their disposition, as marked on the harpins from the mould loft floor. To the cant of the timbers, as marked on the harpins, battens are nailed for their sides; and between those and the battens for the sides of the timbers that form the stern, fixed on the ribbands at the height of the knuckles, other battens are placed, so as to give a regular twist, from the sides of the timbers that form the ports or lights, to the sides of the timbers that partake of the regular cant below.

198. Battens are likewise got in for the disposition of the side counter timber, making the after and outside of this timber, above the upper knuckle, to be in the same plane with the intermediate timbers; that is, those which form the lights, between the midship and side counter timbers; as all the outer edges of those timbers that pass between the lights, should be in the same plane with each other, in an athwartship view; while, in a fore and aft view, they should all tend

to the same point above the stern. (See Figs. 10 and 11, Plate 5.) To the station of the battens that are got in up and down, for the disposition of each timber, moulds are made to agree with harpins and ribbands; and the bevellings are taken by keeping the stock of the bevel out of winding with the battens fixed to the harpins or ribbands, and the tongue of the bevel to the harpins or ribbands. When the sides of the timbers have a curve and twist, the form of the timber is projected on in the mould, fixed in a plane at the shortest distance from its station; and spilings taken for the side, similar to that of the side counter timbers (117), and as explained for the timber of the round stern. (141.)

ON ENLARGING AND REDUCING THE DRAUGHTS AND BODIES OF SHIPS.

When the body of a ship requires to be reduced or enlarged, so as to be similar in its proportions to the one altered from, a process the most simple, and at the same time on principle, being grounded on similar triangles, may be pursued. Various methods may be given for increasing or reducing, in exact proportion, every part of a body; but the example given by the Author, appears to him to be one, which, while it is correct, is of easy application.

When the body is to be enlarged or reduced, find the exact relation in the *Example* that the length, breadth and depth, or draught of water, bear to each other, and at which they are to be brought out. If to be *enlarged*, as in Figure 11 of the Body, Plate 9, produce the loadwater line *a b*, to *i*, and the boundary line *d e* to *h*, making the line *e i* equal to the increased height or draught of water, and the line *o h* equal to the increased breadth, according to their proper relation to each other. Then draw any number of water lines, as *m n*, and produce them to *x*; then take the distances from the point *e*, where the boundary line cuts the upper edge of the keel, to the lines *x x i*, and set them on the line *d e*, and draw new lines, as the dotted lines *s p*. The same may be done for the main and top-breadths, port-sills, or any other heights required, by producing the line *e i* and projecting them out to it, and then carrying them up on the line *d e*, as for the water lines. Having determined all the heights that may be necessary, proceed to obtain the increased breadths; project down the intersection of every timber with the lines *a b* and *m n*, to the line *o h*, as *r*, *r*, *r*; then take the distances from *o*, on the line *o h*, to *r*, *r*, *r*, and set them off on their corresponding dotted lines *s p*, for spots for the new timbers. By proceeding in this manner, at as many heights as may be required, a new and enlarged body may be formed, similar to the original body, as shown by the curve *o k z*.

To *reduce* the body, as in Fig. 12, draw the triangles *o h e, b e i,* so that the line *o h* may be equal to the new reduced breadths, and the line *e i* to the reduced depth, and draw the line *b i* perpendicular to *e i,* and the line *e h* perpendicular to *o h.*

The line *b i* is drawn perpendicular to *e i,* and the line *h e* to *o h,* with a view only to ease in squaring out the lines *m n, i k.* To obtain the new heights from the place where the water lines cut the boundary line *d e,* draw lines out to *e c,* parallel to *b c,* as *m n;* and from *e,* on the line *e c,* take the new heights and set them upon *d e,* and draw the dotted lines *s p* for the new level or water lines. To obtain the breadths, draw down lines parallel to *e h,* to meet *o h,* as *i k;* then from *o,* on the line *o h,* take the distances to the lines *i k,* and set them off on their corresponding new water lines *s p,* which will give spots for drawing in the sections for the new reduced body as the curve.

To obtain the heights and length on the sheer plan, on the reduced or increased dimensions, draw the line A B (Fig. 13), so that the distance from A to B may be the required length between the perpendiculars, and produce the different stations *a b, c d,* down to A B. Then on this line take from A the distance to *b, d, f, h* and B, and set off on the line A C for new stations, as shown by the dotted lines *a′ b′* &c. Then, to obtain the heights, draw the line C K, so that the angle in C K may be the same as the angle *d e c* (in Fig. 11), and project all the heights of the water lines, sheer lines, port-sills &c., or the different heights of the head and stern, to the line C K; and take the distances from *c,* to them in the direction C K, and set them off on their corresponding distances from A, as the new dotted stations *a′ b′ c′ d′,* which will give spots for the new sheers, at their proper positions and increased height. The distance for the increased length may be set off each way from the line ⊕, when the stations, as *a′ b′* and *c′d′,* would be extended each way, so that the increased length would be obtained aft as well as forward from the line ⊕. To reduce the length, we have only to proceed as given in Fig. 12, for reducing the breadth.

APPENDIX.

No. I.

ON TAKING OFF SHIPS.

To take off the Body, Sheer, Profile, and Plans of the Deck.

1. To take off the body of ships, &c. boards of different lengths are prepared with straight edges, having generally feet marked upon them; the boards that are placed horizontally, or after the direction of the keel, are called base boards; and those that are erected either vertically or perpendicular to the base boards, are called perpendiculars.

2. In taking off ships, certain fixed points or lines are determined on, from which all distances are taken, that the form and every part may be readily transferred from the ship to the paper. All distances, longitudinally, are generally taken from the centre of the fore-mast; transversely, from the middle line or longitudinal axis; and as to heights, from the lower edge of the rabbet of the keel.

3. Erect before the knee of the head a perpendicular; and in a line with the lower edge of the rabbet, extend a base board from the keel out to it, keeping an even foot well to the aft side of the perpendicular (Note 18); then, above the figure, carry another base aft, parallel to the upper edge of the keel, from the fore-mast perpendicular, so as to extend abaft the centre of the fore-mast, keeping it likewise with an even foot well to the perpendicular.

4. Before the places for taking the form of the transverse sections of the body can be determined, the place of the greatest transverse section must be found, by first obtaining the widest part of the ship in its length; and should the breadth be parallel to any distance, the extent of this parallel breadth each way should be marked upon the keel, and likewise the distances forward and aft where the sections would be of the same area; then, from the fore and after parts of the body, where the sections would be of the same area, determine the places of

two stations for taking off the form, and from the fore one set off the places of the stations in the fore body, and from the after one, the places of the stations in the after body, setting them off from five to ten feet apart, or as the body may require, carrying them as far to the extremities as a section can be taken with correctness; making those at the extremities nearer together.

5. To take off the form and to obtain the heights, a base board is extended out from the side of the keel, with its upper edge well with the lower edge of the rabbet of the keel, to be beyond the breadth of the ship, and upon it a perpendicular is erected, square to the base board, at an even foot out from the middle line; with the fore side of these boards well to the stations in the fore body, and aft side well to the stations in the after body. (NOTE 19.)

6. The plane of the base board and perpendicular is set square to the keel and athwartships, that the form, when transferred upon the paper, may give sections that are athwartships and perpendicular to the keel.

7. To take off a section, the following form is generally made in a book for the purpose :—

Base.		Perpendicular.		Perpendicular out from the middle Line.	Ft. In.
Out.	Up.	Up.	In.		
feet.	ft. in.	feet.	ft. in.	Height of the upper edge of the wale ..	
1		1		lower deck port sills .... { upper	
2		2		lower	
3		3		upper ditto .... { upper	
4		4		lower	
5		5		sheer strake	
6		6		&c. &c. &c.	
		7			
				REMARKS.	
				Fore side of the —port is from the perpendicular	
				Centre of the foremost dead eye of the main channel is from the perpendicular	
				Preventer bolts from ditto	
				Chain bolts from ditto	
				&c. &c. &c.	

The distances from the base board and perpendicular are taken at every foot; those up from the base board, as far out as the body will admit; and those in from the perpendicular, as far down so as to cross those taken up from the base board; and to direct and keep the measuring battens in the same plane with the base and perpendicular, a fine line is strained from the base to the perpendicular, so as to be nearly in contact with the body; and to keep them perpendicular to the base, &c., a square with a strip fastened to it, to form a rabbet, is applied, with one arm to the base or perpendicular, and the measuring batten is directed to the body by the other.

8. For the different parts connected with the sheer draught, as the head, channels, chain plates, and dead eyes, quarters, and stern, sketches are made in the book, and all the necessary measurements placed on them.

9. For the head, the rails and cheeks are taken by measuring down from the base board, that is over the head, at every foot in; and for the fore part of the knee of the head, gripe and stem, and the fore part of the rabbet of the stem, distances are taken from the perpendicular, before the head, at every foot up. For the cathead, lines are held across the ship, to each cathead, at the outer end, and part where it cuts the side; and the distances down are taken from the base over the head; and for the distances aft, the lines are squared up to the base, and taken abaft the perpendicular before the head.

10. For the chain plates, &c., the distances of the centre of the dead eyes, chain and preventer bolts, are taken from the foremost chain of the channel they are connected with, which is taken from one of the perpendiculars (5), or it may be taken from the centres of their respective masts; and the heights of the channels, centre of dead eyes, bolts, &c. are taken from some of the sheer lines that have also been obtained by the perpendiculars.

11. The quarters are taken from the perpendiculars that cross them; but if there should be but one, the rails of the quarter are generally produced to the next perpendicular before, to obtain their sheer and the distance of the ends of the rails, &c. taken from it; though most of the necessary measurements are taken and placed on the sketch.

12. To take off the stern, one perpendicular is erected right aft, at the middle line, square to the keel in the sheer plane, and vertically on a transverse plane, with its fore edge nearly in contact with the aft part of the taffrail; the feet answering to a base board, produced from the lower edge of the rabbet of the keel. Another perpendicular is placed about the side counter timber, in the same athwartship plane, with the perpendicular at the middle. From these perpendiculars, the heights of the wing transom, decks, rails, taffrails, lights, &c. and the rake of the

stern, are taken; and from the midship perpendicular, the rake of the post, height of the braces, &c. are obtained; and without the side one, the breadth of the quarter, &c. The round aft is generally taken square to the rake, by holding a line across the stern.

13. From the perpendicular before the head, the distances aft of all the stations are taken, and to the perpendicular erected abaft the stern; and likewise, while the base boards at the foremost and aftermost extremities are fixed to the lower edge of the rabbet of the keel, the measurements for the length of the deck, and for tonnage, may be taken; and on the base board over the head, the distance aft to the centre of the fore-mast.

14. Upon the paper draw in a line for the lower edge of the rabbet of the keel, and square to it a line for the foremost perpendicular; then, from the foremost perpendicular, draw aft to the proper height, parallel to the keel, a line for the lower edge of the base board, over the head, and set aft on it the centre of the fore-mast, which may be drawn downwards to the proper rake; likewise from the fore-mast perpendicular set aft the different stations from which the form of the body has been taken and the distance to the perpendicular abaft the stern, and draw them up square to the line for the lower edge of the rabbet of the keel; and then proceed to set off all the heights, distances, &c. as taken at the ship.

15. For the body, a board called a "chequer-board" is provided, upon which are drawn each way, at right angles to each other, lines at a distance apart equal to a foot of the scale that the draught is to be drawn on; then, one line, in the middle of the board, is made the middle line, from which the lines each way are then marked 1, 2, 3, 4, &c., to show the feet they are from the middle line; and one, near the lower part, for the lower edge of the rabbet of the keel; this lower one represents the base board, and the lines upwards are marked 1, 2, 3, 4, &c., to show the feet above. Now the lines parallel to the middle lines that are at the proper distances are made the perpendiculars for the respective stations; then, from the line representing the lower edge of the rabbet of the keel, or base board, the distances, as taken at the ship, are set up, on the lines representing their proper distances out; and from the line for the perpendicular, the distances in are set off, on the lines representing their proper distances up. When this is done, and the transverse form obtained for every station, proceed to obtain the timber line, and the form of the stations at the proper room and space. Draw at ⊕, or the greatest transverse section, the timber line or the thickness of the plank within the sections as taken off; next

run off in the half-breadth plan lines taken from the sections on the chequer-board, and set off on the stations as before got upon the paper (14), that shall be as near as possible perpendicular to the body, and set within them the thickness of the plank, taken at the height that corresponds to them; then set off the room and space for the joints of the frame, which must be taken from the ship, according to the space of the frames, and obtain new sections at these joints for the body, to the timber line.

16. For the profile and plans, sketches are generally made for the different contrivances; and their distances lengthways are taken from the centre of the fore-mast, and transversely from the middle line; these with the sizes and heights above the decks of the different ports, are placed on the sketch; but for the beams and ports, their fore sides are generally taken from the centre of the foremast, and placed in the following form:—

BEAMS.

	No.	Distances.	
Before the mast.	1	— —	
	2	— —	
	3	— —	
Abaft ..	4	— —	
....	5	— —	
....	6	— —	Riding bitts.
....	7	— —	
....	8	— —	
....	9	— —	Riding bitts.
....	10	— —	Fore hatch.
	&c.		&c.

PORTS.

	No.	Distances.
Before the mast.	1	— —
Abaft	2	— —
....	3	— —
....	4	— —
....	5	— —
....	6	— —

The distance of the ports is taken by holding a line across from port timber to port timber; this is done to prove the distance before taken from the station.

17. To obtain the height of the decks, lines are held across the ship from port to port, at the lower sill, at each port of the different decks, if there are ports, if not, from the gunwale; and the distance for the depression of the decks, at the middle and side taken; which is set off on the paper below the corresponding port sill lines or gunwale, as obtained by the stations. The decks below are got from those that are obtained by the ports; and below the lowest deck the depression of the platforms, keelson, cutting down, deadwood, &c. is taken and set off on the paper.

No. II.

ON EXPANDING THE BODY OF A SHIP.

To obtain the Surface for the Length of the Planks, and Quantity of exterior Planking, &c.

1. To expand the body of a ship is to obtain the surface of the exterior or interior part, or to bring the surface upon a plane from two straight lines.

2. To expand the body to obtain a good shift of plank, that the length and breadth of the planks may be known to a certainty, is of importance, both as it regards the conversion of the plank, and the strength of the fabric.

3. In expanding the body, it is extended lengthways from the greatest transverse section, each way, and upwards from the lower edge of the rabbet of the keel; these lines therefore remain straight. In the body plan draw in any number of level lines, keeping one to the height of the wing transom at the side, the heights of the upper and lower port sills, decks, wales, gunwale, and top side, and run them off in the half-breadth plan; and where they cut the stem, stern post, and counter timber, draw them in the sheer plan. In the body plan, pen thin strips of wood round each section, and mark upon them the distance from the side of the keel to all the level lines, port sills, deck, wales, &c.; and in the half-breadth plan, pen other strips round the lines run off there; marking upon them the place of the greatest transverse section, and the stations of the sections afore and abaft it, buttock lines, and the inside of the rabbet of the stem and stern post; and above the wing transom, the aft side of the counter timber. Take, likewise, on a thin batten, the distances along the fore part of the rabbet of the stem, and aft part of the rabbet of the post, to the level lines, wales, deck, &c. at the stem, from some section, and at the stern post from the lower edge of the rabbet of the keel.

4. When the thin strips are thus marked, draw upon the paper, for the expanded draught, a line for the lower edge of the rabbet of the keel, and set off upon it the places of all the stations, and after edge

of the rabbet of the post; then apply the battens for the sections, with the spots marked for the side of the keel, to the line for the lower edge of the rabbet, at their respective stations, and the battens from the half-breadth lines, with the spots for the greatest transverse section kept to the place of this section, also the spots for the other stations kept to their corresponding battens, while they are likewise brought to their respective spots on these battens. When they are thus fixed, they are frequently kept in this position by sharp-pointed pins, till the battens that extend lengthways are brought into their proper positions at the stem and stern-post. Fix the battens that have the level lines, wales, &c. marked upon them, taken from the rabbet of the stem and stern-post; that for the stem with the marks for the stations kept well to their respective stations, as got at the lower edge of the rabbet of the keel, and carried up till the spots upon it are made to agree with their respective battens, and to the spots for the side of the stem, on these battens. The same may be done with the batten for the after edge of the rabbet of the post, except that it is kept with the spot for the lower edge of the rabbet of the keel, well to this line, in the expanded draught, and to the after edge of the rabbet of the post; with this batten the height of the wing transom at the middle is likewise obtained. The places of the battens above the wing transom, at the side counter timber, are obtained by taking the distance to the level lines, deck, &c. above the level line, corresponding to the wing transom at the side, and setting them off in the expanding draught in the direction of the counter timber, from the spot on the batten for this level line, which spot is brought in its proper position, nearly, by taking the breadth of the wing transom on the round aft, and setting it off by fixing one point well to the height of the wing transom, as got on the batten for the aft side of the rabbet of the post, and the other to the said spot, and bringing them to the spots for the aft side of the timber, on their respective battens. When the battens are properly fixed, the spots for the buttock lines, obtained on the battens that extend lengthways, are then marked, and all the battens marked in, which will give the decks, wales, port-sill lines, &c. stations of the sections, the fore part of the rabbet of the stem, after part of the rabbet of the post, and the aft side of the counter timber. To get the wing transom or tuck, when the plank runs up to the lower counter rail, extend the buttock lines and breadth of the wing transom, in the body plan, by taking the distances of the buttock lines and breadth upon the curve, from the round aft, and marking them upon the transom or lower counter in this plan; then pen a batten on the round up, and mark, by the outside of the rabbet of the post, buttock lines, and end of the transom or line for the end of the planking; and bring this batten to the expanded draught, fixing the spot for the outside of the rabbet well to the spot on the post or middle line, for the upper side of the transom or tuck; and the spot for the end, to the spot given on the batten, that extends lengthways, for the level line at the end of the wing transom; and to obtain the intermediate parts, pen battens in the sheer draught round the buttock lines, and mark upon them the upper side of the wing transom, margin, and level lines, and the disposition of the fashion piece. Apply these battens to the expanded draught, keeping them to the spots before obtained on the level lines, and at the upper side of the wing transom, with the spots on them coinciding with their corresponding lines, and mark them by; marking at the same time the spots for the fashion piece, which, with the buttock lines, will be wanted if the surface of the transom is required, and a shift of inside planking given.

5. The body may be expanded by a shorter method, when exactness is not required, by placing the battens for the sections, with the spot for the lower edge of the rabbet of the keel well to the stations of the respective sections, and sweeping towards the extremities all the spots for the level lines, wales, deck, port-sills, &c. arcs of circles, from the stations as squared up, and then bringing the spots for the sections, on the battens that extend lengthways, to intersect with these arcs. This method will be nearly correct.

6. It is in this expanded draught that the shift of plank is frequently given; and if the surface of timber &c. is required, it can be obtained. If the shift of inside planking is given, the scantling of the timbers is got in to the sections in the body plan, and the distance to the side of the keelson, taken round the interior curve, below some deck already got in the expanded draught.

No. III.

ON THE APPEARANCE OF SHIPS IN DIFFERENT POSITIONS, WITH THE METHOD OF OBTAINING IT, ACCORDING TO THE RULES OF PERSPECTIVE.

1. Perspective is the art by which the representation of any visible object is drawn on a plane surface, such as it would appear if that surface were transparent and interposed between the object and the eye. This is the foundation of true painting. Without a knowledge of the principles of perspective, the artist works at random, not attending to the niceties of measure and proportion.

The first step in commencing a picture consists in determining and fixing the geometric situation of certain points; which points, when connected, produce lines; and these lines, whether straight or curvilinear, constitute the first principles of a picture, and give the outline, which it afterwards requires the painter's hand to dress with light and shade. But if the artist has not the outline of every object in his picture, as well as its position, correct according to the rules of perspective, the picture will be without truth and life.

2. Geometry is the foundation of perspective, and by means of it the outline is correctly drawn; but as it is intended here to give only a few particular rules for obtaining the outline of ships in different positions, geometry, as connected with the principles on which perspective depends, as well as light and shade, are left to be studied from those treatises that enter fully upon the subject, and of which there are many in print. However, it will be necessary for a student, before he can put a ship into perspective, to know how to obtain certain points, which will be here explained, and also to be able to delineate the different plans of a ship, and obtain the forms of different sections that cut the body in the several directions, which have been explained in the foregoing directions for *Laying off Ships*, and of which examples will be given in the following pages.

3. In proceeding with these explanations, it may be observed, that the art of perspective is not essential, either in making or executing the

design of a ship; but it is an accomplishment that gives a correct idea of *effect;* which in forming a design, will enable us with more certainty to give that appearance to the hull which will accord with the idea of a handsome ship: and therefore this is introduced here, as the author is not aware of any work which treats expressly on this branch of perspective.

4. The rules of perspective are formed by considering the intersection of the visual rays reflected from the contour of any object to the eye, as they may be seen by representing this object on a pane of glass, which pane may be considered as representing the plane of the picture between the eye and the object.

5. The delineation of it on the glass will depend on the situation of the eye in relation to the pane of glass,—should the objects be near the glass, the spaces they occupy will be larger than when they are at a greater distance; and as the situation of the eye is altered, so will the objects be altered; but in whatever situation the eye may be placed, the horizon or imaginary line that appears to intersect the earth and sky will be on a level with the eye. As the vision is occasioned by rays or pencils of rays coming in straight lines from every part of the object to the eye; and it is by joining these points in the supposed plane of the picture at the pane of glass, through which all these pencils of rays respectively pass, that an exact representation must be formed of the object as it appears to the eye, according to its particular position and distance. For those who intend to study perspective, not with a view to become painters, but only as it relates to the appearance of ships in different positions, a few general observations only will be necessary to enable them to accomplish this object, and these shall be as brief and concise as possible.

6. The point of sight in perspective (sometimes called the point of view, as they both coincide, so far as the picture is concerned) is an imaginary point or spot in the picture, to which the eye is directed; and is in fact the centre of the picture, or of a circle, which in a natural view would take in all that the eye could compass at one fixed station without moving the head: in a common picture, this point is generally at the middle, or varying either way from the middle, at most, not more than one-sixth of the breadth of the picture; and is fixed as to height, in the horizon or vanishing line of the ground plane, or the line, in viewing natural prospects, where the earth and sky appear to unite (5). But in bringing objects like ships into perspective, or any capital object in the picture, the horizontal or vanishing line on which

the point of sight is fixed, is best situated, to give a proper effect, at about three-fourths the height of the ship or principal object, from the lower part;—so that it may appear sufficiently elevated above the horizontal line, and at the middle, or so that the object may be rendered pleasing to the sight, while its position on the picture is so placed as not to diminish its beauty; for if a large object is placed too near the base of the picture, the parts near will appear too large, and those more remote too diminutive.

7. The angles or points of distance, under which the principal objects are to be viewed, are distances or points on the perspective plan, set off from the point of sight at the distance which the eye is supposed to be from the plane of the picture (6), as it regards the principal object in it. These by artists are generally considered to be best situated somewhere between 50° and 60°; that is, for each extremity of the object, from a line drawn from the point of sight to the object, the eye should subtend these angles; however, the distance must always be such as to command, at the same time, a good view of the several parts of the body required to be taken. If there are several ships or objects in the picture, the distance is from the nearest intended to be represented. As a general rule, some artists take the length of the picture as the distance.

8. To obtain a more comprehensive view of the application of the point of sight, and point of distance, a few principal examples may be given. Let *a b c d* (Fig. 1, Plate 9), represent a square, and ABCD, the plane of the picture or a transparent surface through which the square *a b cd,* is to be viewed. Let D be the height of the spectator's eye, and DE an horizontal line to represent the vanishing line of the ground plane; on it place the point F, when D will represent the point of distance, and F the point of sight. Now, if we draw from the plane *ab c d,* the visual rays *a* D, *b* D, *c* D and *d* D, we have on the transparent plane, A B C D, the representation of the square, as *m n o p.*

9. To find in perspective the place of any given points or lines, we have to fix, as before, the point of sight and point of distance. Let A B (Fig. 2) represent the base of the picture, and DE the horizontal or vanishing line, F the point of sight, and D the point of distance. Let *a* and *b* be the points, and *a b* the line to be put into perspective: from the points *a* and *b,* draw the lines *a c,* and *b d,* perpendicular to the base A B, and from *c* and *d,* distances equal to *c a* and *d b,* to give the points, *e* and *f;* and draw the lines, *e* D and *f* D, and *c*F and *d* F, their intersections in *g* and *h* give the two points, which being joined, give the line *g h,* in perspective.

10. In the same manner any figure may be obtained in perspective. Draw the base line A B, and the horizontal line D E (Fig. 3), and fix the point of sight F, and the point of distance D, as before. Let *a b c*, be the figure to be put into perspective. Draw the lines *a d*, *c e*, and *b n*, perpendicular to the base A B, and set off the distances *d a*, *e c*, and *b n*, from *d*, *e*, and *n*, respectively, for the points *m*, *f*, and *o*. From *m*, *f* and *o*, draw the lines *m* D, *f* D, and *o* D, and from *d*, *e* and *n*, the lines *d* F, *e* F, and *n* F. Lines joining the points of intersection *y*, *x* and *z*, will give the figure in perspective.

11. To obtain the elevation of any points, the perspective appearance of the points *a*, *b*, *c* (Fig. 4), is first obtained in the manner explained in the foregoing Example (9), as *y*,*x*,*z*. The elevation of the points is then marked off on any part of the base, according to the height intended. Let O P be equal to this height, and draw the lines O D, P D, to intersect at D, on the vanishing line of the ground plane. If these points are to be of the same height above their respective points, one distance, O P, will be sufficient; but if each point is to have a different elevation, the distances for each must be set off in the same manner on the base, as O P. In this Example, let them all be of the same elevation; draw the lines *m z*, *n y*, and *o x*; then the parts *m z*, *n y*, and *o x*, in the triangle O D P, will give the heights of the points z', y', x', above *y*, *x*, *z*, respectively. As O P would be the height of any object at the base of the picture, and would vanish at the horizontal line or vanishing line of the ground plane, the elevation at any intermediate space would be according to the distance from the base, and may be obtained, as described in this figure; that is, by taking the heights above the base, and setting them off as *m*, *n*, *o*, on the triangle O P D.

12. The method, as described for a single point in these Examples (9), requires only to be repeated to find the perspective appearance and elevation of any number of points; and, as the appearance of any right line may be obtained by finding the extreme points, so any curve may be found by obtaining any number of points, which, when found in perspective and a curve passed through them, will give the exact appearance of the curve. The same may be carried out to get the perspective appearance of ships, as they are solids formed by curved and straight lines; for, in the same manner as we find one point in perspective, so any number may be found; and from them, lines and surfaces may be drawn; and if we can obtain the elevation of one point in perspective, there is no difficulty in getting as many as may be required for the formation of any figure. But the manner of laying down the geometrical plans of the different parts to be shown,

must be known and properly delineated before ships can be put in perspective.

13. In proceeding with the examples necessary for putting ships into perspective, we shall first take the most easy position—that of a vessel above water, with the larboard bow inclined towards you: Fig. 5 is the sheer and half-breadth plan; Fig. 6, the body plan; and Fig. 7, the geometrical plan, with the ship brought into perspective. Draw a line for the real base A B, and, above it, the horizontal or vanishing line D E, which may be about two-thirds of the height of the vessel at the midship section, as this height appears to give the best effect. The point of sight F, or the point to which the eye is directed, will be the centre of the picture, whatever may be the number of objects; and, for effect, it should be some distance before the middle of the length of the ship, or principal object.

14. Let the ship be in a position, as it regards the line of her keel, as *x y* (Fig. 7), and transfer the different sections, as 1, 2, 3, 4, 5, 6, 7, from the sheer plan, to the line *a b* in the geometrical plan, and draw them perpendicular to *a b;* transfer likewise from the sheer to the geometrical plan, the stem, the fore-part of the knee of the head, taff-rail, with the length of the load-water line *l*, and main and top breadths S and M; and draw the curves as shown in this plan. It may be proper before we proceed to get the ship into perspective, to state that the base A B, which is supposed to be the base of the picture, and where every object would appear at its natural height, should be drawn in correct relation to the horizontal line or level of the eye, which we have before supposed, for effect, to be two-thirds of the height from the water line to the gunwale; we shall therefore have to obtain a new base, as G H, for the convenience of setting the heights in perspective, which will agree with the upper edge of the keel. To obtain this base, set up a spot F, at section 4 in the sheer plan, two-thirds of the height from the water line to the gunwale; this spot will agree with the point of sight, F (Fig. 7); then take the distance from this spot to the upper edge of the keel in the sheer plan, and set it below F, in the geometrical plan (Fig. 7), to give the new base, G H, which it may be convenient to have when the whole depth of the ship is required.

15. In proceeding to obtain the ship in perspective, the most simple mode to be pursued is, to get the appearance of the water-line first; to do which, in the geometrical plan (Fig. 7), square up to the intersection of this line with the sections 1, 2, 3, 4, 5, 6, 7, likewise where it cuts the half-breadth of the stem and stern-post, to the base of the

picture, and from these squarings up, draw lines to the point of sight F, as F *a* and F *b;* then, with a pair of compasses, take the distances of each squaring up, from the base to the intersection of the water line with the sections, and set them off on the base, from *a* and *b*, for the spots *c* and *d*, and from these spots draw lines to the point of distance for the visual rays, as *c* D, *d* D; and their intersection, *m n*, with the vertical rays, *a* F, *b* F, will give spots for the water line, which being gone through, for the intersections of the water line with all the sections, stem and stern-post, and a curve passed through the spots thus obtained, the form of the water line will be given on the ground plane; but, as the water line will be elevated above this plane, spots for its elevation must also be obtained. Draw below the sheer draught and body plane (Figs. 5 and 6) a base line A B, at a distance below the point F, equal to whatever the horizontal line D E, and base line A B, in the geometrical plan (Fig. 7), may be apart. From this line, in the sheer and body plans, all heights are to be taken; and from the base line A B, in the sheer plan (Fig. 5), take the heights where the water line intersects the sections 1, 2, 3, 4, 5, 6, 7, and stem and stern-post, and set them off on the base A B (Fig. 7); from any perpendicular, as O D, obtain a spot for each, as P, and draw the line P D. Now, if these heights or elevations were to be immediately at the base of the picture, the whole height O P, would be set up; but, as every object would vanish at the horizontal line D E, all elevations will diminish, or objects become smaller, the nearer they are to the vanishing line, or the further they are placed back from the base. If, therefore, we have to obtain the elevation at the sections 4 and 5, O P will be the height of the water line above A B in the sheer plan at 4, we have to take the height *m* above A B (Fig. 7), or where the visual ray, *c* D, crosses the vertical ray *a* F, and set it up above A B, on O D and P D, and draw the line *m c*, when the distance *m c* is to be set up above *m*, on the vertical line *m c*, when *c* will be the spot for the water line, at the proper elevation; in the same manner we proceed with the section 5, and the remaining sections, stem, stern-post, &c., when a curve passing through the spots thus obtained, will give the correct appearance of the water line. For getting in wales, sheer lines, gunwales, &c., the same process must be pursued as for the water line. To get in the head and stern, if for the knee of the head, mark any number of spots on the fore part in the sheer plan (Fig. 5), and take their distances from the perpendicular P, and set them off before the corresponding line, P P, on *x y*, in the ground plan (Fig. 7); when it only remains to get the spots for them in perspective, and set the elevation above them, as taken from the corresponding spots on the knee in the sheer plan, in the same manner as for the water line.

16. For the stern, any number of spots may be marked on the stern, as 7, 8, 9, and 10, in the body plan (Fig. 6), and transferred, as to their distance from the middle line to the ground plan (Fig. 7), when we may proceed to get these spots in perspective, and take their elevation from the body plan, in the same manner as pursued before. For the rake of the stern, take from the after perpendicular *z z*, the point *o*, and set it off on *x y*, in the ground plan; and, in the same manner as before, get in perspective the point and elevation.

17. To obtain the position of the masts, it will be necessary to get their proper places, as at the height of the gunwale on the ground plan, as *z z z* (Fig. 7), and proceed to get the points and elevation as just described,—observing, when the mast rakes, to mark a line on the mast at any height up, *x*, and project the mast down at this height on the gunwale, and place the positions of these projections on the ground plan (Fig. 7); when you have only to proceed to get these projections in perspective as before, taking the height of the lines *z x*, above A B in the sheer plan, for the elevations.

18. In this position of the ship, a line must be obtained to show the termination of the buttock, as it will appear to the eye. Draw in the body plan (Fig. 6), as many level lines above the water line as may be required, *r*, *r*, *r*, and get these breadths in the geometrical or ground plan on the side farthest from the base, and proceed to obtain their view in perspective, as for the load-water line; their intersections will show the termination of the body as it will be presented to view. As the number of elevations that will be required before the hull of the ship, in whatever position it is to be shown, can be got in perspective, is great, the operation of setting them off would be facilitated by drawing the base, A B, and vanishing line of the ground plane D E, in their proper relation to each other on separate paper, and setting off the distance on the base, as P Q, and drawing the triangle O P Q, so that the height may be easily taken and transferred to the proper drawing. Facilities in drawing in the form, may be likewise obtained, by getting the lines for the visual and vertical rays by similar triangles, with a proper knowledge of geometry; but for those persons who have this knowledge, it is not required to be given here, as they will take their own plans; and to give it would only render the explanation more obscure to those who are not acquainted with geometry.

19. From the Examples already given, the manner of getting a ship correctly in perspective is shown; and it only remains to give one or

two examples in which the ship is varied in her position, to obtain a clear idea how the appearance of the hull may be got correctly in any situation in which it may be placed.

20. In the explanations given, the bow of the ship is supposed to be inclined towards the spectator, but in an upright position, in relation to its vertical axis; but in these Examples (Figs. 8 and 9) the ship, longitudinally, will be in the same position, but her vertical axis inclined, or what is commonly termed, "she will be heeling."

21. In this Example, the longitudinal axis *x y*, in the ground or geometrical plan, and the points of sight and of distance may be the same as in the former example; but it will require the body plan to be got in an inclined position, and the fore and after bodies to be got in separately, (as shown by Fig 8) to have both sides. The vanishing line D E, and base line A B (Fig. 8), should be drawn at the same distance from each other (as in Fig. 9), fixing the point F, for effect, two-thirds the height of the gunwale, on the side most raised above the water. In transferring the different points or breadths from the body (Fig 8), to the geometrical plan (Fig. 9), they must first be projected down the base A B; to obtain a breadth at the gunwale for section 4, draw the lines *a b*, from the gunwale *b*, perpendicular to the base, and take their distance from the vertical axis P O, and set them off separately on each side of *x y* (Fig. 9 *a a*), the same must be done for the water-line *d c* (Fig. 8), and set off on each side of *x y* (as *c c* Fig. 9). The spots will give points for the curves, which must be got into perspective, as explained in the former example. Proceed in the same manner for every other line required to be got in, as wales, ports, &c.; and for the head and stern, their elevations are there to be taken above A B (Fig. 8), and applied above the base, as before explained, by constructing the triangle D O P, and making the base O P, always equal to the elevation required.

22. It may be necessary to give one more Example, so that most of the positions in which ships can be placed, may be explained;—at least, the rules that may be involved in every example, by placing ships in any position. In this example, the ship's head is to be elevated above a horizontal line, and the stern inclined towards the spectator. As there would be considerable trouble in drawing another sheer draught as much as may be necessary, it will answer every purpose required in the explanation, to draw a new base M N (Fig. 5), at a distance from the point F, and perpendicular to the base, equal to the distance D E, from the horizontal line A B (Fig. 10), making this base M N the

same angle with the keel that the head of the ship is intended to elevate. In the geometrical plan (Fig. 10), draw the line, *x y*, for the longitudinal axis or line of the keel to an inclination, that the ship is intended to be viewed with, the stern towards the base. Draw, perpendicular to it, a line to represent section 4, and to represent a line passing through *h* (Fig. 5), and to which all other lines will be referred. If we require a distance for the fore part of the figure-head, draw the line *q s* perpendicular to M N (Fig. 5), and transfer it by taking the distance *s*, from *h*, and setting it off from 4 on *x y* (Fig. 10). Proceed in the same manner to get this point in perspective, taking the elevation *s q* above M N, and applying it on the geometrical plan, as before explained, for taking the elevation of any point in perspective. To get the gunwale and wale, draw the lines *x z* and *i k* perpendicular to M N (Fig. 5), and take their distances from *h*, as *h i*, *h z* and set them off from 4 (Fig. 10), as *k z*, and draw lines across, parallel to 4, and on these lines set off the corresponding breadths of the ship at the wale and gunwale, from *x y* (Fig. 10), and obtain their points with their elevations (*k i*, *z x*, Fig. 5) in perspective. For the stern, as M *m* or any other points, they are first projected down perpendicular to M N, and their projected distances taken from *h* on M N, and set off from section 4 on *x y* in the geometrical plan, and lines drawn across parallel to 4, when the breadth of the ship at the respective places is marked on them; and, as before, the points and elevations are got in perspective.

23. For the stern, the points M *n*, are got from *h* (Fig. 5), and the round of the stern in the geometrical plan *q m r*, *p n o*, drawn, and any number of breadths taken from the stern (Fig. 6), and set off on them, when their points and elevations may be got, and obtained in perspective as before, and the curve drawn through them to give the form of the ship in perspective.

NOTES.

Note 1, *page* 4.

It is necessary to obtain a fair body, that in whatever number of lengths the body may be laid off in, from the shortness of the mould loft floor, that one or two timbers of each corresponding part should be got on the other; that the lines may overrun each other.

Note 2, *page* 20.

In trimming the timbers of the frame, it is necessary that the moulding side of the frame timbers should be trimmed straight and out of winding, or else there can be no certainty in the application of the moulds and bevellings. To trim the floors or cross timbers: they are sided, when they have considerable rise, or are very acute, two lines are held on the outside of the arms, sufficiently on to make the side straight, so as to coincide with each other beyond the breech; and a long straight-edged batten held so as to be at equal distance from these lines, and the distance taken and set off on each arm, on the inside and outside of the floor, if the lines are not in contact with the floor. This is done at as many places as may be necessary to get the spots sufficiently near, to line; and from the lines thus got, the floor is trimmed through straight; when it will be out of winding, upon the principle, that three straight lines which meet one another must be in the same plane. To side a floor that is less acute, fix a line to the extremity of the arms, sufficiently on the moulding side, as before, to make it straight; and place at the middle, a straight batten, faying upon the piece, and coinciding with the line: then, at such distances as will be near enough to line the floor, hold another straight batten, out of winding with the one fixed, and take the distance from it to the line, which distance set off on each side; lines struck through the spots thus obtained, and the floor trimmed through straight, will be out of winding. To mould the floor or cross timbers, the floor or cross timber mould is laid flat, and spots for the line on the mould that represents the floor marked on the piece; boring through, with a small gimblet, such parts of the line as cannot be marked without; mark, likewise, the battens for the head and sirmarks, the line for the cutting down middle line, and the battens for the side of the keel. The mould is then taken off, and the first futtock or the half floor mould is then applied, with the corresponding heads and sirmarks kept to those marked on the piece, and from this mould the spots kept to the form is rased by. The scantlings are then set off at the head and sirmarks, and a batten, or sometimes a mould for the purpose, is applied, and made to pass through them, and to the cutting down, and marked by.

To set off the bevellings for the different sirmarks and head, the bevel is applied square to the curve, keeping the stock out of winding with a batten placed at the middle line. For the bevelling for the cutting down, the stock is applied parallel to the middle line, and the piece is then counter moulded; the inside is made to follow the outside.

To side the futtocks, fix a line in the hollow part, from end to end, sufficiently on to make the piece straight, and place a batten in the middle, faying to the side of the piece, and coinciding with the line; then, with another batten, placed out of winding with the first, at distances sufficiently near to line the piece, take the distance to the line, and set it off on the out and inside of the piece: a line passing through the spots thus obtained, and the piece made straight through, will have its side straight and out of winding. For small timbers the shipwright frequently, by the means of three or four fir planks bolted together, makes a surface straight and out of winding, which he calls a signing or scribing board; on this he lays the timber to be sided, and with a pair of compasses, set at a proper distance, marks a parallel line round the timber. To mould the futtocks, lay the mould on, mark by its edge, and the places of the heads and sirmarks; and prick off at each head and sirmark, the bevellings taken from the board for the corresponding head and sirmarks; the stock is placed square to the curve, and out of winding, with a batten fixed at the middle; the timber is then counter moulded, and the scantlings, from the scantling stick, set off at each head and sirmark, and the inside trimmed through, after the outside.

Note 3, *page* 23.

The stem is sided from a middle line, by placing a long straight-edged batten at each end, out of winding with each other, and holding a line from batten to batten, and projecting spots upon the piece in the same plane with the battens and line, observing, in placing the line and battens, that they are placed so as to have wood on each side, to make the piece straight. The middle line is got in this manner, on both sides, and marked on the piece; the half siding is then set off on each side, from the middle line to the given siding, and made straight, taking the siding below; for the lower end, from the keel, at the lower scarph, as from this place the keel increases in size, to which the stem must be made to correspond. The stem is moulded according to the mould, and trimmed through, square. To set the stem in its proper position, bring a line from the head, in the direction to correspond with the line marked upon it, and set the stem till this line is perpendicular to the keel, and to the spiling taken from one of the square stations; it is then to its rake; to bring it upright, or in a fore and aft plane at the middle line, range a line, fore and aft, well with the side of the keel, and produce it forward, so as to be before the fore part of the stem, at the head; then, from the head of the stem, at the middle, drop a plumb, when it falls to the half-siding of the keel, from the line produced forward, the head of the stem is vertical from the middle line of the keel. The plumb should likewise be dropped from the middle line, at the fore part of the stem, at different distances down, that the middle may be in the same vertical plane with the keel all the way up, as the middle part may bag on one side or the other.

Note 4, *page* 23.

The fore foot is sided from a middle line, and tapered from the fore end aft, as many feet aft as there are fourths of inches in the difference between the siding of the fore end and the keel, in midships. The fore foot is moulded by the mould, and trimmed through, square at the upper and lower parts, when the stations of square timbers, and a straight line, with the upper end of the keel, is marked upon it.

Note 5, page 24.

The foremost piece of deadwood is sided by laying the mould on the different pieces, and marking them upon it. All those that cross the stepping are trimmed through first to the full siding of the outer part of the stepping, from a middle line which is got on each side of each piece; the mould is then laid on, and the stepping marked by; above, it is then trimmed to form the rabbet for the stepping, and below, to the half-breadth battens; and those pieces that come above, need only be trimmed straight to the siding of the deadwood above the stepping. The several pieces are then brought together, and treenailed; and the deadwood is moulded, and the stations of the cant timbers from the deadwood mould marked in, above the stepping; the square timbers are likewise marked on it, that the deadwood may be placed in its proper position.

The after deadwood is sided and trimmed as explained for the fore deadwood, except, that sometimes a plank is brought on to form the stepping, when it is trimmed to the same siding below as above the stepping, as low down as this siding will cut the half-breadth battens, where they partake of the form of the body, and below, to the form given by the half-breadth battens; by this means considerable timber is saved, as all the pieces before, that crossed the stepping, must have the full siding to the outside of the stepping.

Note 6, page 25.

The stern post is sided by fixing a batten at each end at the middle line, out of winding with each other, and getting the middle line on each side, when the proper siding is set off at the head and heel, and the sides trimmed straight through, the mould is laid on, and the rabbet and bearding line marked on it. The inner post is sided to correspond with the stern post, as low down as the bearding, below which it is trimmed to the bearding, as given from the mould-loft floor.

Note 7, page 25.

When the rabbet is in the middle of the stem, the knight-heads or stem-piece moulds are then made to the line got in for the aft side of the rabbet (Fig. 2), and they must be sided so as to fay to the stem, otherwise they are made to the bearding line on the side of the apron. When they are sided, in both cases, the mould is laid on, and the level lines and sirmarks marked upon the piece; and the stock of the bevel, when the bevellings are pricked off, is kept in the directions of the level lines and tongue, horizontal. When the knight-heads are bolted, the bolts are marked on the stem, to keep the knee of the head bolts clear of them.

Note 8, page 30.

It will be found necessary, when the joints are opened considerably, to run off two moulding edges for the form of the timbers, especially in small vessels, as the edges will be altered considerably; and it is the case sometimes, that the whole of the cant timbers are laid off as single timbers, when each timber of the frame has a moulding edge.

Note 9, page 32.

To side the cant floors, lay the mould on the piece, in the position in which it will mould, and mark the middle line; the mould may then be removed, and the mould for the cant applied, fixing it on the two arms, sufficiently on to side the piece, and perpendicular to the middle line. If it is a cross timber, and only one angle at the middle, fix a straight-edged batten at this place, taking away the piece till it coincide with the mould; then draw lines upon the piece, parallel to the middle line, or perpendicular to the mould, and apply a straight-edge batten at each, out of winding with the one placed at the middle line, and take the distance from it to the edge of the mould, which set off at the upper and lower parts of the floor; and through the spots thus obtained, lines are struck; and the piece trimmed through straight. If a floor, there are two angles formed, one on each side, at the side of the deadwood, above the stepping; between these two angles, the piece is trimmed through to the mould first, when a line for each angle is marked upon it; after which it is trimmed through to the mould for the cant, as explained for the cross timber. The piece is then moulded as explained for the floors (Note 2), the cant floor mould being laid flat on both arms, by means of hinges at the joints.

Notes 10 *and* 11, *pages* 37 *and* 40.

To trim the wing transom to the round up, lay the mould on the piece (the piece is supposed to be converted, and is only to be trimmed), and mark upon it the middle and buttock lines. On the upper part, to the middle, place a batten, faying with its straight edge upon the transom; and fix the round up mould, with its vertex coinciding with the batten, and perpendicular to the middle line both up and down, and athwartships; then, in the direction of, and at each buttock line, place a straight-edge batten, out of winding with the one at the middle, and take the distance to the mould, which distance set down on the fore and after side of the transom; and through the spots thus obtained, pen a batten, inside and out, and trim the transom through straight, in the direction of the buttock lines, and the transom will be formed to its true round up, square to the sheer. The lower side is trimmed after the upper.

To trim the transom, the moulding way is first trimmed through to the bevelling of the margin; and the margin drawn in below and parallel to the upper side, then, the bevellings for the part below the margin, are pricked off, by keeping the stock, as before described (83), and the lower part is counter moulded.

Note 15, *page* 71.

Upon the moulds for the flight of the cheeks is in general marked the fore side of the rabbet of the stem, which mark, when the mould is applied, is kept as much abaft the cheek, at the knee, as it is before the fore side of the rabbet. Before the flight mould is applied, lay the mould on for the moulding of the cheek, to obtain the direction of the knee and place of the rabbet; after which, fix the flight mould in its proper position, keeping it off as much at the after part as the knee tapers, as it is made upon a fore and aft plane; then, draw lines, sufficiently near together to have the curve correct, perpendicular to the mould across the piece: to one of these lines fix a straight-edged batten, and with another batten, placed out of winding, with the one fixed at the other lines, take the distance down to the flight mould, and set it off on each side of the cheek, and through the spots obtained pass a curve with a thin batten, and trim the cheek through straight in the direction of the lines, and the upper side will be to the true flight. For the lower side, take the depth of the mould at each of the lines drawn upon the cheeks perpendicular to the mould, and set it off below the upper side on both edges of the cheek, and trim the lower side through straight, in the same direction as the upper.

Note 16, *page* 83. *Plate* VIII.

Several practical methods are used to find spots in a segment of a circle, that shall pass through any three given points. Those that follow are the most in use.

Case 1. (Fig 14). Let D B be the round up intended to be given to the mould in the length A C. It is required therefore to find spots to form a segment of a circle to pass through A, B, and C. From B draw the two straight lines B A and B C, and we have the angle A B C in the segment A F B E C; then, since it is the property of circular arcs, that the angles in the same segment are always equal (see Euclid's Elements by R. Simpson, Book 3, Prop. 21), if we draw two lines from A and C, which shall make an angle equal to A B C, the point E, at the angles, is a point in the circumference of a circle passing through A, B, and C. Therefore, for the practical way of describing the arc, join two battens A B and B C to form the angle, A B C; then, if the batten A B be kept to the point A, and the batten B C to the point C, if removed to E, the point E will be in the circumference, and if passed round to as many points as necessary, will describe the circular arc, A F B E C.

Case 2. (Fig. 15). Let R P be the round up, in the given length, M O. Draw the line P O, and from P draw the line P *x*, making the angle O P *x*, equal to the angle O P R; divide the round up R P into any number of equal parts, and set them up from P, on the line P *x*. Then draw the lines M *z* through the divisions on R P, and the lines O *v* to the divisions on P *x*, and the intersections of the corresponding lines in *z* will give points in the circumference.

Case 3. (Fig. 15). From the given round up draw the line P M, and bisect it in *m*, and from *m* draw perpendicular to P M the line *m n*, then from P M, on the line *m n*, set up one-fourth the round up, for a point in the circumference. Again join *n* M and *n* P, bisect them as before, and set up one-fourth of *m n* for the points *t*, for other points in the circumference. This method, though most commonly used, will not give a true circle.

Case 4. (Fig. 16). To find spots for a segment of a circle, that will pass through A, D, and B, C D being the given round-up in the length A B; join D B, and bisect it in E; set off on a straight batten a distance F G equal to E D; and apply the batten parallel to A B, and at such a distance from it, that H F may be equal to H E, the point F being kept in the line C D, G is a point in the circle. (MORGAN.)

Note 17, *page* 84, *plate* 7, *Fig.* 14, B

When the rail is to be trimmed out of a straight piece, as a piece of thick stuff, which will prevent a large piece of timber being used for the purpose, draw a straight line from the two knuckles, and where the lines drawn parallel to the rake cut it, draw lines parallel to the sheer, to the line drawn perpendicular to the sheer from the knuckle of the midship timber; and form a round-up to these lines, and the round aft as before explained.

Note 18, *page* 81.

It is seldom the case that ships are so situated in the docks as to allow the perpendicular before the head to be brought down directly, to the base produced from the keel; it is therefore in general carried down in the form of steps, with the feet still marked, as to the distances aft and up, on the short base boards and perpendiculars that form them.

Note 19, *page* 92

The base and perpendicular are placed in this manner in relation to the stations, that the measuring battens may be applied more correctly.

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